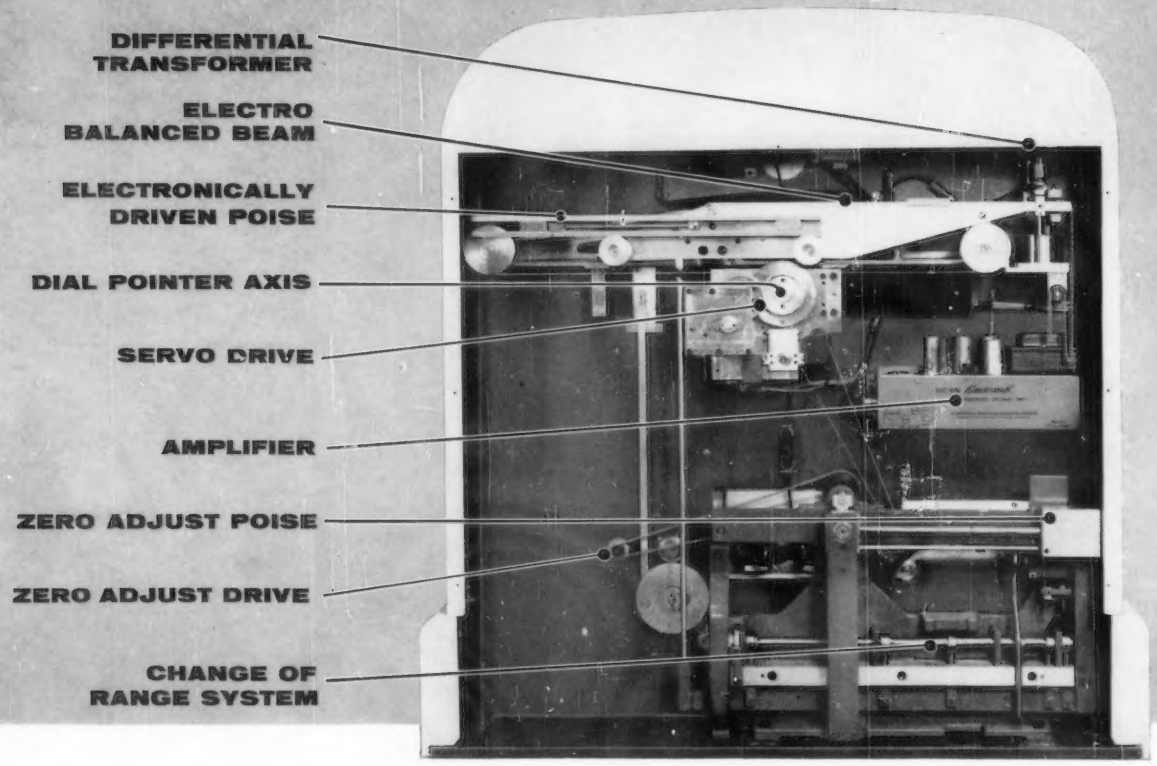
ASTM Bulletin

ASTM COMMITTEE WEEK—FEBRUARY 4-8
Benjamin Franklin Hotel, Philadelphia



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ASTM BULLETIN

DECEMBER 1956

Number 218

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ASTM Bulletin is indexed regularly by Engineering Index, Inc.

The Society is not responsible, as a body, for the statements and opinions advanced in this publication.

ASTM Bulletin, December 1956. Published eight times a year, January, February, April, May, July, September, October, and December, by the American Society for Testing Materials. Publication Office—20th and Northampton Sts., Easton, Pa. Editorial and advertising offices at the headquarters of the Society, 1916 Race St., Philadelphia 3, Pa. Subscriptions, United States and possessions, one year, $2.75, two years, $4.75, three years, $6.50; Canada, one year, $3.25; two years, $5.75, three years, $8.00. Other countries, one year, $3.75, two years, $6.75; three years, $9.50. Single Copies—50 cents. Number 218. Entered as second class matter, April 8, 1940, at the post office at Easton, Pa., under the act of March 3, 1879.
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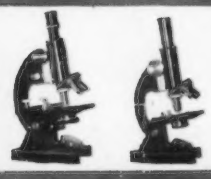

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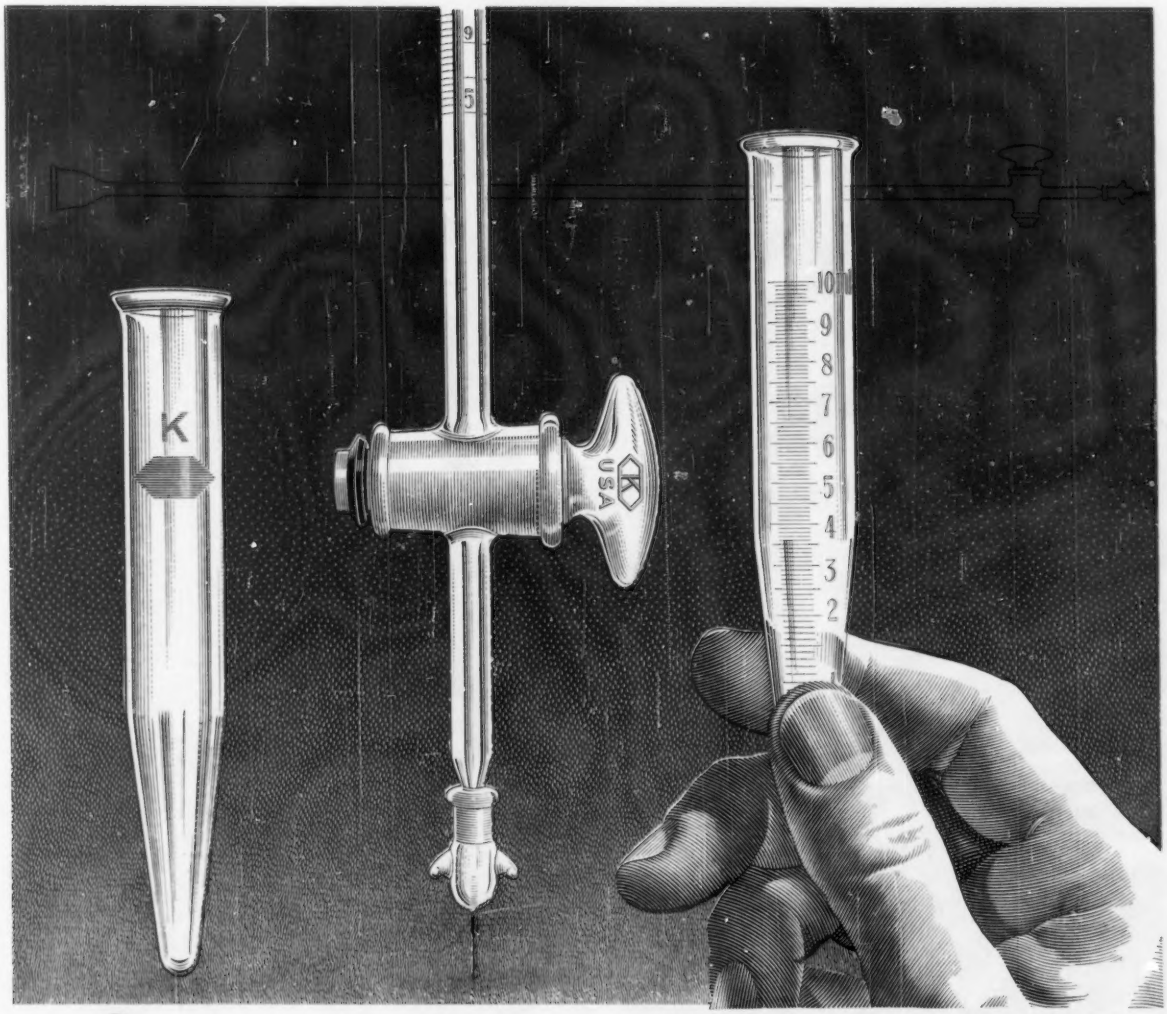

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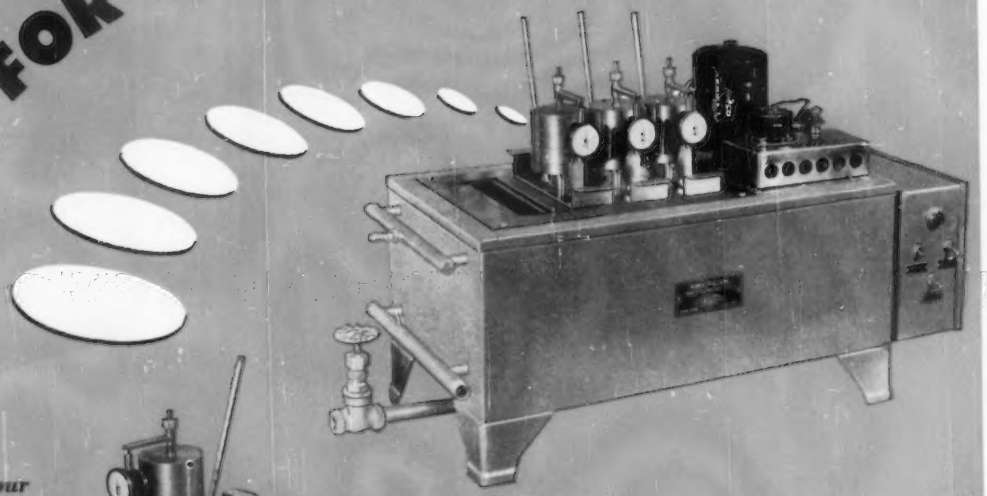

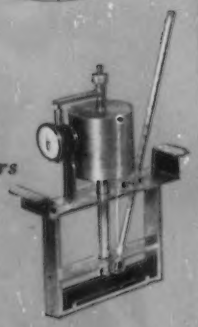

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ASTM BULLETIN

"Promotion of Knowledge of Materials of Engineering, and Standardization of Specifications and Methods of Testing"

Number 218 December 1956

1957 COMMITTEE WEEK

Technical Committees to Meet in Philadelphia, February 4—8; Symposium on Thermal Insulating Materials Featured

PHILADELPHIA, ASTM Headquarters city, will be host to the Society's members, committee members, and visitors attending the 1957 Committee Week meetings at the Benjamin Franklin Hotel, February 4 to 8.

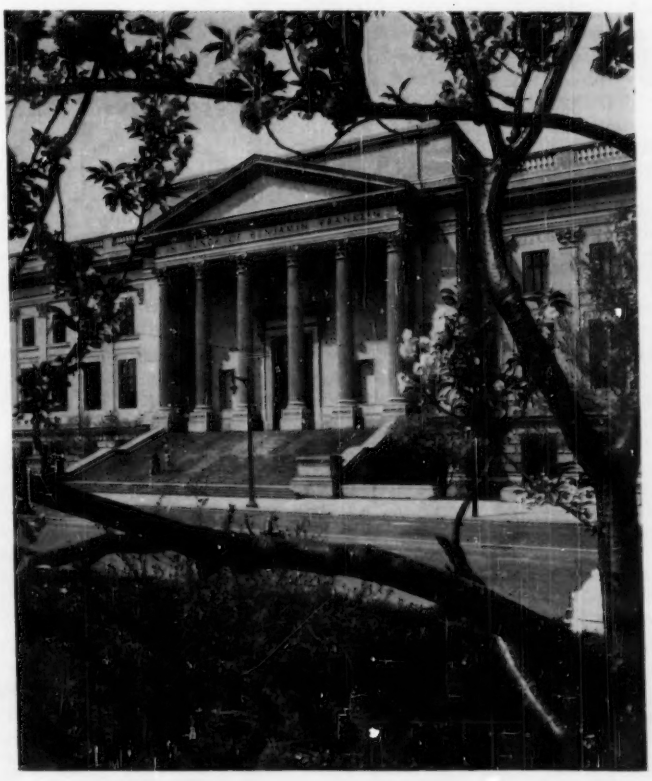
In addition to the concentrated activity of the 200 meetings of the 26 main committees and subgroups, a symposium on thermal insulating materials will be held in two sessions, morning and afternoon, Wednesday, February 6. The symposium is sponsored by Committee C-16 on Thermal Insulating Materials.

The ASTM Philadelphia District, long experienced in arrangement-making for the Annual Meetings held in Atlantic City, is planning the week's only official social event for Tuesday evening at Philadelphia's famed Franklin Institute. Following a social hour and a dinner, members will enjoy a showing at the Institute's planetarium. Tuesday evening is strictly for fun—not technical, no speeches.

A letter containing hotel and dinner reservation forms was mailed on December 15. Members are urged to make their plans and return their reservations as soon as possible.

As this issue goes to press, the technical committees listed below have indicated that they will meet in Philadelphia:

A-5 on Corrosion of Iron and Steel
A-10 on Iron-Chromium, Iron-Chromium-Nickel
B-3 on Corrosion of Non-Ferrous Metals and Alloys
B-6 on Die-Cast Metals and Alloys
B-7 on Light Metals and Alloys
B-8 on Electrodeposited Metallic Coatings
B-9 on Metal Powders
C-7 on Lime
C-8 on Refractories
C-11 on Gypsum
C-12 on Mortars for Unit Masonry
C-15 on Manufactured Masonry Units
C-16 on Thermal Insulating Materials
C-22 on Porcelain Enamel
D-4 on Road and Paving Materials
D-5 on Coal and Coke
D-7 on Wood
D-11 on Rubber and Rubber-Like Materials
D-16 on Industrial Aromatic Hydrocarbons and Related Materials
D-22 on Methods of Atmospheric Sampling and Analysis
D-24 on Carbon Black
E-1 on Methods of Testing
E-5 on Fire Tests of Materials
E-6 on Methods of Testing Building Constructions
E-7 on Nondestructive Testing
E-9 on Fatigue
E-10 on Radioisotopes and Radiation Effects



After the Committee Week Dinner at the Franklin Institute, guests will enjoy a special showing at the planetarium.

Symposium on Thermal Insulating Materials February 6—Benjamin Franklin Hotel, Philadelphia

Errors in Thermal Conductivity Measurement by the Guarded Hot Plate Due to Guard Ring Unbalances—W. Woodside and A. Grant Wilson, National Research Council

The authors investigated the unbalance errors of three different designs of guarded hot plate (including the 8-in. NBS design) and the dependence of these errors in the size and direction of the unbalance, the size and design of the hot plate, the thermal conductivity and thickness of the sample being tested, and the hot plate–cold plate temperature difference. Samples of ten materials, ranging in thermal conductivity from 0.17 to 2.30 Btu in. per hr per sq ft F, were tested in the three sets of apparatus.

An Improved Guarded Hot Plate Thermal Conductivity Apparatus with Automatic Controls—Zeno Zabawsky, Armstrong Cork Co.

This paper describes an 8-in. guarded hot-plate apparatus constructed according to the requirements of ASTM Methods C 177 but with a number of changes that increased the versatility of the apparatus, enabling the securing of thermal conductivity values to 1 per cent by automatic means. The preliminary work on this apparatus was reported in a paper by C. E. Gilbo at a symposium in 1951 (Experiments with a Guarded Hot Plate Thermal Conductivity Set).

The Use of Envelope Type Cold Plates in Thermal Conductivity Apparatus—C. F. Gilbo, Armstrong Cork Co.

The use of this envelope simplifies the construction of the apparatus as well as its operation and control. The experiments described were part of a series of studies that started in 1944 to develop a thermal conductivity apparatus that could be used at very low temperatures. It was also desirable to be able to take these measurements on 3-in. thick samples. The apparatus was to be one that would meet standard test procedures.

Thermal Conductivity of Insulation Containing Moisture—F. A. Joy, Pennsylvania State University

A transient heat-flow method, based on the theory of an infinite-line heat source, was found suitable for the measurement of the thermal conductivity of insulation containing moisture. The measurement is fast and the temperature rise small, thus avoiding the large displacement of moisture which renders the guarded hot plate (ASTM C 177) unsatisfactory for the purpose. The thermal conductivity of three representative insulating materials was tested in a wide range of moisture content at two temperatures—above and below freezing.

The information presented in this paper is of a fundamental nature, not suitable for immediate use in field installation problems.

Criteria for Testing Underground Piping Thermal Insulation—D. D'Eustachio, Pittsburgh Corning Corp.

In many cases of underground insulation the layer of insulation does not decrease over-all heat loss from the pipe because the earth cover by itself is enough insulation. Under these conditions, the major function of the insulation is to provide a sharp thermal gradient near the pipe so that an adequate low-cost, water-excluding coating can be applied to protect the pipe from corrosion. This situation, more common in underground installations than many people realize, means that testing programs for underground thermal insulating systems should give major attention to the prevention of corrosion and not to heat transfer.

Stress-Corrosion Cracking of Insulated Austenitic Stainless Steels—A. W. Dana, Jr., E. I. du Pont de Nemours & Co., Inc.

Stress-corrosion cracking of austenitic stainless steels is often associated with the presence of stress, residual or applied, and of environments containing chlorides. One particular situation where cracking can occur is when certain thermal insulations are used over austenitic stainless-steel equipment operating at temperatures of 50 to 110 C, and the insulation becomes wetted. Here the cracking has been attributed to the action of water-soluble chlorides leached from the insulations.

The author describes a "Wick Test" developed for the purpose of defining the relative susceptibility of austenitic stainless steel to stress-corrosion cracking as a function of exposure to the various insulating materials.

Recently Declassified Papers in Symposium on Nondestructive Testing in Nuclear Field—April 16-18

NONDESTRUCTIVE tests developed in the field of nuclear energy will be the subject of a symposium to be held at the Morrison Hotel, Chicago, Ill., April 16 to 18, 1957. Information stemming from 15 years of research and development in testing applications in the nuclear field will be presented for the benefit of those interested in using nondestructive test methods in industrial applications from recently declassified papers.

The papers will be divided into three categories: (1) reactor materials, including: fuel, sheath or cladding, control and moderator material; (2) completed fuel assemblies; and (3) miscellaneous. Papers will be presented in the morning and afternoon sessions each day and in the last two evenings authors of the day's program will take part in panel discussions.

The symposium will include papers prepared for oral presentation and some for presentation by title only. Papers will not be available prior to the meeting but all will be subsequently published by ASTM.

The symposium is sponsored jointly by the American Institute of Chemical Engineers, the American Nuclear Society, ASTM, and the Society for Nondestructive Testing. An outline of the program will appear in the January issue of the ASTM BULLETIN.

The chairman of the symposium is W. J. McGonnagle, Argonne National Laboratory, who represents the Society for Nondestructive Testing. Other committee members are W. P. Bigler, Argonne National Laboratory, representing the American Nuclear Society; F. L. LaQue, International Nickel Co., representing ASTM; Stuart McLain, Argonne National Laboratory; H. Migel, Magnaflux Corp., representing the Society for Nondestructive Testing; J. L. Swanson, Aircraft Nuclear Propulsion Dept., General Electric Co., representing the American Inst. of Chemical Engineers; S. A. Wenk, Battelle Memorial Inst., representing the Society for Nondestructive Testing; P. D. Johnson, for Nondestructive Testing; and E. A. Wiggin, Atomic Industrial Forum.

Actions on Standards

Steel

Specifications for Seamless and Welded Austenitic Stainless Steel Tubing for General Service (EA-A 269),

Specifications for Seamless Austenitic Chromium-Nickel Steel Tubes for Refinery Service (EA-A 271),

Specifications for Seamless and Welded Austenitic Stainless Steel Pipe (EA-A 312),

Specifications for Heat-Treated Steel Tires (EA-A 329).

The first three specifications are under the joint jurisdiction of Committee A-1 and Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys, and on their recommendation the Society at the 1956 Annual Meeting approved revisions of the specifications which consisted of incorporating in the specifications the provisions covered by alternates which related to the columbium-tantalum content. Approval was given on Nov. 21 to withdrawal of the emergency alternate provisions.

The emergency alternate of A 329 was originally prepared in order to keep the manganese ranges consistent with those of the Specifications for Steel Tires (A 26). As the result of the acceptance by the Society of a revision of Specifications A 26, the manganese ranges of Specifications A 26 and A 329 have been brought together.

Wrought Iron

Specifications for Iron and Steel Chain (A 56 – 39) (Approved Nov. 14)

Responsibility for this specification has been under the joint jurisdiction of Committees A-1 on Steel and A-2 on Wrought Iron. Committee A-1 is writing a proposed tentative specification for carbon steel chain which will be issued under a new designation number. The designation A 56 applies to the new specification brought in line with current practice in the production and procurement of wrought iron chain. The title is changed to Tentative Specifications for Wrought Iron Crane Chain.

Methods of Testing

Tentative Specifications for Weighing and Drying Apparatus for Microchemical Analysis (E 124 - 56 T) (Approved Oct. 18)

These specifications are the first prepared by the new Subcommittee on Microchemical Apparatus of Committee E-1. They were originally prepared by the Committee on Microchemical Apparatus, Division of Analytical Chemistry, of the American Chemical Society. This work, under way in the ACS since 1949, has now been transferred to the ASTM. These specifications cover the following types of microchemical apparatus: combustion boats, weighing bottles, weighing cup, weighing tubes, spatulas, forceps, tare flasks, metal cooling block, metal crucible container with glass cover, and drying apparatus.

Following the completion of this first standard, the subcommittee will give consideration to other types of microchemical apparatus, which will include not only glassware but metalware, filters, etc. The design of microchemical apparatus is in general closely related to and determined by its manner of use. It is, accordingly, necessary for the committee to give consideration to such matters in the preparation of detailed specifications covering the design, form, and dimensional requirements of this type of specialized analytical laboratory equipment.

Tentative Specifications for Apparatus for Determination of Water by Distillation (E 123 – 56 T) (Approved Nov. 14)

These new specifications, the first for laboratory volumetric glassware, cover apparatus used in Tentative Method of Test for Water in Petroleum Products and Other Bituminous Materials (D 95 – 56 T).

Standard Specifications for ASTM Thermometers (E 1 – 56) (Approved Nov. 15)

Revision includes the following: (1) addition of two flash point thermometers for vegetable oils, requested by Committee D-1 on Paint, (2) addition of set of eight solidification point thermometers, prepared for Committee D-16 on Industrial Aromatic Hydrocarbons, (3) addition of two tank thermometers for Committee D-2 on Petroleum Products, and (4) several changes in the existing thermometers specifications.

Tentative Method of Testing and Standardization of Etched-Stem Liquid-in-Glass Thermometers (E 77 – 52 T) (Approved Nov. 15)

This revision comprises the addition of a test for permanency of pigment which has been developed as a result of the more permanent type markings now used in thermometer graduations. Information on the determination of ice point on thermometers, which formerly appeared in an explanatory note in Thermometer Specifications E-1, has been transferred to these test methods. Other minor changes, largely editorial, have been made to clarify the text.

Tentative Methods of Impact Testing of Metallic Materials (E 23 – 47 T) (Approved Nov. 8)

These methods, which were carefully studied and reviewed over the past three years have been drafted into a final form considered by the committee to be far superior to the previous methods. They relate specifically to behavior of metal when subjected to a single application of a load resulting in multiaxial stresses associated with high rates of loading, with low temperature, or combinations of both, the mechanics of which subject the metal to a notch effect. Title has been changed to "Notched Bar Impact Testing of Metallic Materials."

Quality Control

Tentative Recommended Practice for Probability Sampling of Materials (E 105 – 54 T) (Approved Oct. 29)

This practice is primarily a statement of principles for guidance of all ASTM committees and others in the preparation of a sampling plan for a specific material. The present revision incorporates the suggestions of ASTM members who have used it since it was first published in 1954.

NEW ASTM PUBLICATIONS

Symposium on Properties, Tests, and Performance of Electrodeposited Metallic Coatings

THIS symposium, sponsored by Committee B-8 on Electrodeposited Metallic Coatings, was presented at the 1956 ASTM Spring Meeting in Buffalo, and again at the ASTM Second Pacific Area National Meeting in Los Angeles, in September, with an additional paper included.

This symposium, bringing together at one time summaries of tests on coatings conducted over a period of years, outlined the role of Committee B-8 in a combined progress report and report of work accomplished. The papers and the ensuing discussion from both presentations point up areas in which further study can be conducted profitably. The broad scope of this Symposium is indicated by the titles below:

History of ASTM Committee B-8—*William Blum, National Bureau of Standards*

Corrosion Behavior and Protective Value of Copper-Nickel-Chromium and Nickel-Chromium Coatings on Steel—*C. H. Sample, International Nickel Co.*

Evaluation of Methods Available for Measurement of Surface Luster of Electroplated Coatings—*G. B. Bowman, Standard Steel Spring Division, Rockwell Spring & Axle Co.*

Recommended Practices for Cleaning Prior to Electroplating—*S. Spring, Kelite Co., and Members of Section K of Subcommittee IV of B-8*

Comparison of the Corrosion Behavior and Protective Value of Electrodeposited Zinc and Cadmium Coatings on Steel—*C. H. Sample and R. B. Teel, International Nickel Co., and A. Mendizza, Bell Telephone Laboratories*

Evaluation for Testing Methods for Supplementary Coatings—*R. E. Harr, Western Electric Co.*

Atmospheric Exposure of Electroplated Lead Coatings on Steel—*A. H. Du Rose, Harshaw Chemical Co.*

The Standard Salt-Spray Test—Is It a Valid Acceptance Test?—*A. Mendizza, Bell Telephone Laboratories*

Evaluation of Phosphate Coatings on Electrodeposited Zinc—*A. L. Alexander, Naval Research Laboratory*

Order *STP No. 197* from ASTM Headquarters, 1916 Race St., Phila., Pa. Price: $3; to members, $2.25.

Symposium on pH Measurement

JUST what is the pH value? What are its restrictions and limitations? What is recommended standard practice for measurement? What about measuring pH at high temperatures and pressures, in nonaqueous solutions, in blood—and what is involved in instrumentation for pH measurements? These and other questions are answered or clarified in this Symposium on pH Measurement, sponsored by Subcommittee 22 on Hydrogen Ion Determinations of Committee E-1 on Methods of Testing and presented at the June 1956 ASTM Annual Meeting in Atlantic City.

In the ten years that have elapsed since the first Symposium on pH Measurement was held, significant developments in pH instrumentation and technology have been made. To keep pace with the expanding application of pH measurement, an operational definition of experimental pH values has become generally recognized. Agreement on standard pH methods is gradually being achieved as a single conventional standard scale comes slowly into general use throughout the world. Techniques have been devised for the accurate measurement of pH under specialized conditions of unusual difficulty, and much thought has been given to the precise role of pH in reactions of interest to the analytical and physical chemist. The increased laboratory and industrial importance of nonaqueous and partially aqueous solvents has stimulated the search for functions that will give a useful indication of the level of acidity and basicity in these media. It is the purpose of this second Symposium on pH Measurement to consider these new developments and to clarify the problems they have created.

Titles and authors of papers are as follows:

Foreword—*E. B. Ashcraft, Westinghouse Research Laboratories*

Meaning and Standardization of pH Measurements—*R. G. Bates, National Bureau of Standards*

Performance Studies of Reference Electrodes and Their Components at High Temperatures and Pressures—*J. E. Leonard, Beckman Instruments, Inc.*

Modern Developments in pH Instrumentation—*W. R. Clark and G. A. Perley, Leeds & Northrup Co.*

Problems in Measurement of the pH of Blood and Other Biological Fluids—*Julius Sendroy, Jr., Naval Medical Research Institute*

Quantitative Applications of pH Measurements in Analytical Chemistry—*Henry Freiser, University of Pittsburgh*

Theoretical and Practical Problems in the Measurement of Acidity in Nonaqueous Media—*Martin Kilpatrick, Illinois Institute of Technology*

Indicator Acidity Functions for Nonaqueous and Mixed Solvents—*M. A. Paul, Harpur College, and F. A. Long, Cornell University*

Copies of this 104-page symposium *STP No. 190*, can be obtained from ASTM Headquarters, 1916 Race St., Phila., Pa. Price: $2.50; to members, $1.85.

Symposium on Specific Gravity of Bituminous Coated Aggregate

SPECIFIC gravity has an important role in the present-day design and measurement of compaction of bituminous pavements. It is customarily used in determining compaction of the bituminous mixtures. In the past, it has been the practice to measure individually the specific gravity of each component in order to determine the correct mixture proportions. This has not been an accurate or satisfactory procedure.

The five papers discuss various procedures whereby the specific gravity of the bituminous mixture may be measured quickly and accurately using small portions of the compacted mixture. The authors discuss the pitfalls involved in the choice of bulk and apparent and true specific gravity as a means of determining the proper ratio of bitumen to aggregate.

Titles and authors of the papers of this symposium which was held at the ASTM 59th Annual Meeting in June, 1956 under the sponsorship of Committee D-4 in Road and Paving Materials, are as follows:

The Role of Specific Gravity in the Design and Control of Bituminous Paving Mixtures—*C. A. Carpenter*

Measurement of Bituminous Concrete Core Specific Gravities and Specific Gravities of Bituminous Coated Coarse Aggregates by Means of a Volumeter—*F. M. Williams, L. E. Grimmer, M. M. McAdams, and S. Yanoshek*

Measurement of Maximum Theoretical Specific Gravity of a Bituminous Mixture by Solvent Immersion—*P. J. Serafin*

Development and Application of the Effective Specific Gravity of Bituminous Coated Aggregates—*J. R. Martin and A. H. Layman, Jr.*

Maximum Specific Gravity of Bituminous Mixtures by Vacuum Saturation Procedure—*J. M. Rice*

Specific Gravity and Voids Relationships in Bituminous Pavement Mix Design—*J. L. McRae*

Order from ASTM Headquarters, 1916 Race St., Phila., Pa. Price: $2; to members, $1.50.

ASTM Methods for Chemical Analysis of Metals

THIS greatly expanded 1956 edition provides in the latest reedited form all the methods published in the 1950 edition plus many new testing procedures that have been perfected and approved by Committee E-3 on Chemical Analysis of Metals. This volume is the only one in which these 47 standards appear in convenient book form.

The methods have been chosen as suitable for determining compliance with specification requirements with the minimum expenditure of time and effort, consistent with accuracy. While primarily of a referee nature, the methods are widely used as the basis for somewhat more rapid techniques for routine analysis. Many of the methods, particularly the photometric procedures, while of referee accuracy, are sufficiently rapid to be used for routine purposes also.

The several spectrochemical methods included in the book were prepared by ASTM Committee E-2 on Emission Spectroscopy. Also included are data on standard samples of metals issued by the National Bureau of Standards.

Greatly enhancing the usefulness of this publication is the detailed index which lists each method and procedure under at least two broad headings; the metal, and the substance to be determined. All methods in certain special classes such as photometric and electrolytic are so listed. No effort has been spared to make the index of maximum serviceability.

Copies of this 640-page cloth-bound volume can be obtained from ASTM Headquarters, 1916 Race St., Phila., Pa. Price: $8; to members, $6.

ASTM Standards on Zinc-Coated Iron and Steel Products

THIS 144-page publication presents in a convenient form for reference the various ASTM standard and tentative methods of test and specifications pertaining to zinc-coated iron and steel products. They represent the most up-to-date thoughts and practices and are recommended for industry usage because of substantial agreement of the various groups represented on technical committees of the Society.

The compilation is sponsored by Committee A-5 on Corrosion of Iron and Steel and includes all the specifications coming under the jurisdiction of this committee. There have also been added certain selected specifications written by Committees A-1 on Steel, A-2 on Wrought Iron, B-1 on Wires for Electrical Conductors, and B-2 on Non-Ferrous Metals and Alloys.

Order from ASTM Headquarters, 1916 Race St., Phila., Pa. Price: $2.25; to members, $1.70.

Reference Photographs for Magnetic Particle Indications

A DOCUMENT which has been discussed for many years by manufacturers and purchasers of iron and steel castings has finally reached fruition —Tentative Reference Photographs for Magnetic Particle Indications on Ferrous Castings (E 125–56 T). The collection of reference photographs covers types and degrees of discontinuities occurring in steel castings and other types of ferrous castings detectable by the dry powder magnetic-particle method. They are intended to assist in the classification of these discontinuities and to be used for comparison with the indications observed on actual castings. The reference photographs have been reproduced through the courtesy of the Steel Founders' Society from photographs obtained from its member companies.

Forty-seven reference photographs are included, covering linear discontinuities (hot tears and cracks), shrinkage, inclusions, internal chills, and unfused chaplets, porosity, weld discontinuities, false indications, and magnetic anomalies. The explanation of the reference photographs as well as four charts which include reproductions of the photographs are available from ASTM Headquarters at a price of $2.50; to members, $1.85.

X-Ray Diffraction Data Offered to Schools at Special Prices

THE X-Ray Diffraction Data Card File published by ASTM is now being offered to educational institutions at 80 per cent discount from the list prices. The discount is offered only on the basis that the card file will be used for classroom instruction. A certification to this effect is necessary in order for the special discount to apply.

ASTM handles much of the mechanics for the Joint Committee on Chemical Analysis by Powder Diffraction Methods which has compiled data for the identification of approximately 5000 crystalline materials by the Hanawalt method. The Joint Committee is sponsored (in addition to ASTM) by the American Crystallographic Assn., the British Institute of Physics, and the National Association of Corrosion Engineers. The data have been collected from industry, literature, and laboratories and are available on plain 3 by 5-in. cards, 4 by 6-in. Keysort cards, and standard IBM cards. The Keysort cards have the Keysort coding around the border with holes punched but not notch coded. Instructions for coding are supplied with the Keysort cards.

Beside the great demand for these data by research laboratories, geological and research departments of universities, government and industrial laboratories in the United States and Canada, this X-Ray Diffraction Data File is being used by many laboratories in Great Britain, France, Italy, Germany, Belgium, Sweden, Switzerland, South America, Indonesia, Africa, Australia, Malaya, and Japan.

The editor of the card file is G. W. Brindley, Pennsylvania State University. Associate editors are: Benjamin Post, Polytechnic Institute of Brooklyn, Sigmund Weissman, Rutgers University, and L. G. Berry, Queen's University, Canada. Several Research Associateships at the National Bureau of Standards have been established by the committee for the review, selection, and preparation of new patterns of standard materials as required.

Literature and schedule of prices of the X-Ray Diffraction Data Card File will be furnished by writing the X-Ray Department, ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

ACR Notes

Administrative Committee on Research

A Threat to Research

By Walter J. Smith

As a people, we are proud of our modern society with its widespread bounty, modern conveniences, health protection, and hopeful future for our children. Most Americans accept all of this without thinking. A few, however, have realized that these attributes are created by technological advances made possible through research. But how very few indeed understand that our way of life and our national strength can only be maintained and improved if the spirit and activities of research are continually nourished and kept vigorous. Failure to understand the importance of research could easily lead to a serious decline of our economy. Even now there are signs of what might come. To insure the future for ourselves requires not only timely recognition of our shortcomings but also that prompt corrective action be taken.

Research is not something which concerns only industry, Government, and a few special people in laboratories; as a vital feature of our whole economic structure, it is everyone's business.

Of course no one, except those specially trained, expects to be familiar with the theory and detail of research work. In fact, the term "research" implies so much that it almost defies simple, yet adequate, definition. Even those directly engaged in research can themselves encompass only a limited area, and they do well merely to keep in touch with the progress of others. However, everyone, whether he is technical or not, can be fully aware of the necessity for research. Everyone should be aware that our creative system based on research will endure only as long as there exists an ample flow of new workers—a stream of well-trained, ambitious, imaginative young people eager to tackle the unknown.

It is unnecessary to dwell on the present serious shortage of engineers and scientists. Some people minimize it as an inconvenience of the present time. Others maintain that the situation will correct itself and that high salaries will eventually attract more young men into the technical professions. They forget that it takes from four to ten years to educate and train an effective research worker. To inspire this worker requires top-notch teachers on the high school and college levels. And the low academic salaries in comparison with those of industry strongly encourage the potential teacher or professor of science to pass up a career in the classroom and join the rush.

Besides an inadequate number of research workers, there is a disturbing tendency toward fewer dedicated research workers in the ranks of newcomers. This condition, of course, is associated with the absence of competition for jobs. Some young graduates are professed opportunists who shop unashamedly for the "softest deal." Perhaps this attitude conforms with an economic law. It does not create a healthy future for research.

People who consider our national strength have turned to research as an essential policy. In the Soviet Union, for example, enormous effort is expended on the education and training of young scientists and engineers. While we are beginning to falter in our training program, they are vigorous and expanding in theirs. Should we therefore be astonished to find that we are rapidly being overtaken in technology?

It is not our purpose to reiterate what so many already know very well. But it must be made perfectly clear to everyone that whatever threatens the quality and vigor of our research threatens our strength as a nation. This threat now exists at a time of world disquiet when we can ill afford to sacrifice our strength.

Various solutions to the problem have been proposed. Higher salaries for teachers are essential, of course. In Massachusetts, a promising start has been made with the Lexington Plan by which teachers alternate classroom duties with an industrial position. Also, the suggestion that retired scientists and engineers be allowed to teach technical subjects in high schools and colleges has merit and certainly shows progressive thinking.

By adding our voice of concern to others, we hope that the cry will be heard, so that eventually the cooperative effort of Government, industry, and schools will be able to correct the present faults. Only then can we look ahead with confidence.

V. P. Weaver Honored by Committee B-5

At its October meeting in Hershey, Pa., Committee B-5 on Copper and Copper Alloys expressed its appreciation to V. P. Weaver of the American Brass Co., the retiring secretary, for his many years of service.

Among the gifts presented to Mr. Weaver were a gold watch, a parchment scroll, and a Jimmy Hatlo autographed cartoon depicting "A Committee Meeting." Also the indirect assistance of Mrs. Weaver was recognized by a cash "orchid."

In addition to gifts, Mr. Weaver received a scroll containing the following verbal bouquet:

The Members of Committee B-5 have heard with great regret that Vincent P. Weaver has found it necessary to resign as Secretary of this group after 12 years of meritorious service.

His service in this capacity has been outstanding, recognized by producers and consumers of copper products and by the headquarters staff of the American Society for Testing Materials. Mr. Weaver's distinctive attention to Committee B-5 activities is more readily appreciated when one realizes he has also been quite active in the deliberations of such other groups as ASTM Committee B-1 on Wires for Electrical Conductors, ASTM Committee B-7 on Light Metals and Alloys, the ASTM Non-Ferrous Metals Coordinating Committee, and the Non-ferrous Subcommittee of the ASME Boiler and Pressure Vessel Committee. He has also been appointed as ASTM representative on the Non-Ferrous Metals Committee of the Society of Automotive Engineers. With all these other appointments, Mr. Weaver has still devoted his most intense efforts so that the membership of Committee B-5 has been kept currently advised of the projects within that group, and so that the actions of Committee B-5 would be handled expeditiously by the parent Society.

The Members of Committee B-5 will long remember his valuable contribution, and their utmost appreciation is extended to him for this 12 years of service on their behalf.

Super Materials for Super Performance*

By LT. GEN. C. S. IRVINE
Deputy Chief of Staff (Matériel)
United States Air Force

"Propulsion systems for aircraft and missiles have reached a stage of development and complexity where progress is almost always limited by our knowledge of available materials"

In the Air Force we are keenly aware of the contributions you and your fellow engineers and scientists have made toward the improvement of aircraft and air weapon systems, and we sincerely appreciate them. In regard to current progress, no one can deny that you have done and are doing, a good job. But you must put on the pressure, not only in terms of national economic progress, but in terms of military needs as well. Projected requirements for National Defense, resulting from a technological revolution which is progressing at rates of geometrical proportions, are placing a tremendous burden on the resources of our country. Nationally, it is our intent to protect and preserve the American way of life. On the international scene, our total intent is to help all peoples everywhere to preserve their right to choose their own way of government.

The mission of the Air Force in support of these aims presupposes our maintaining a margin of operational and technological superiority over any potential aggressor nation. A vital demand exists for the brainpower of our strategists, our scientists, and our engineers, to break through all barriers and enable us to have that superiority.

Russians Trim Our Lead

This demand is made forcefully clear in the face of an accelerated technological build-up within the Soviet Union. Within the short space of time since the end of World War II, they have trimmed our scientific lead from over ten years, to very much less.

In recognition of this challenge, my intention is definitely not to lull you into a complacent attitude of self-satisfaction by giving you 20 minutes' worth of flattery for jobs well done. Rather, I shall briefly review the work now being done, emphasize the requirements facing both industry and the military in the near future, and vigorously urge you to exert every ounce of your creative, scientific know-how in developing better or radically new materials for the aircraft and weapon systems of tomorrow.

In 1923, shortly after Lt. Al Williams set a speed record of 266 mph, authorities called a halt to speed contests on advice of medical authorities that flyers now had "Achieved the maximum speed in the air which is possible without grave risk to human life." Today, 33 years later, the Cornell Aeronautical Laboratory is using a newly designed shock tube to explore speeds up to 22 times the speed of sound. Between these extremes of 4 miles per minute, and approximately 4 miles per second, current materials research has far exceeded the limitations of the past, and is hammering at the outer barriers halfway toward the new frontiers.

In the modern weapon system, our entire vocabulary is rapidly changing. We calculate speed in terms of Mach numbers. We speak of tropospheric and stratospheric altitudes, unlimited range, megaton bombs, radar "lock on," automatic fllight control and landing. We have the century series of supersonic fighter aircraft in being—the F-100, -101, -102, and 104. We have the new B-58 and B-66 bombers, the C-130 and C-133 turboprop transports, and the backbone of our air fileet, the B-52, with its supporting KC-135 jet tanker. Development of important weapon systems results in companion commercial types—so you will soon have for civilian use the Boeing 707, the Douglas DC-8, and the Lockheed Electra. Tremendous new advances in military weapon systems are boiling in the pot of progress.

The Modern Weapon System

But just what is a "weapon system?"

A weapon system is an air vehicle, engineered, developed, and produced, to perform a specific mission. Its ground environment is an essential and integral element of the system.

Basic to the development of any new air weapon, is the impelling requirement for real functional supremacy over its predecessors.

The military problem of continuously maintaining this weapon supremacy potential, therefore, is initally, primarily a research problem, followed by

* Presented by General Irvine as the feature address of the President's National Luncheon held on September 19, 1956, during the ASTM Second Pacific Area National Meeting in Los Angeles.

thorough development, test, and production. The relationship of materials development to this military problem becomes apparent when we recognize that the selection of materials constitutes one of the major building blocks for all engineering design.

Progress in aviation is no longer possible by making advances in only one of the engineering areas involved. Commensurate progress in all fields is necessary to attain successively higher plateaus. Today's aircraft are closely integrated systems, rather than haphazard combinations of loosely connected components, as they were not so long ago. For example, evolution of the jet engine did not in itself give us combat-worthy jet aircraft. There had to be commensurate progress in aerodynamics, electronics, structures, controls, instrumention, and ground facilities, before jet aircraft could be employed effectively in routine operations. Continued advances in propulsion capability cannot be exploited unless similar advances in aircraft design permit the effective utilization of the new engines.

Materials Limit Progress

Propulsion systems for aircraft and missiles have reached a stage of development and complexity where progress is almost always limited by our knowledge of available materials. We know, however, that many improvements and new approaches toward harnessing energy for aircraft propulsion have already been conceived and their practical development depends only on design ingenuity and suitable materials for their construction.

If the engine designers should run out of ideas for making things hotter for the materials engineers, they can turn to the fuels and combustion people for assistance. The high energy-release rates possible from special fuels under development may prove most difficult to solve from a material standpoint.

Requirements exist for improved materials for the compressor and turbine sections, combustion chambers, and afterburners of our future propulsion systems. In three or four years propulsion system developments that we must have will result in turbojet engines capable of over Mach 3 operation. In just a few years commercial air transportation will dictate a similar requirement. For example, this will require compressor discharge temperatures over 1500 F and turbine inlet temperatures over 2500 F. In this same time period, we will have nuclear propulsion systems; this means that, in addition to temperature problems, the situation will be further complicated with radiation problems. Likewise, our intercontinental bomber missiles may be achieving speeds of Mach 20—with temperatures in the area of 10,000 F or more.

Materials are therefore needed that are suitable for use at these temperatures, and have strength-weight ratios and service availabilities comparable to our currently used materials. Furthermore, since our aircraft propulsion systems require a significant portion of the scarce or strategic alloying materials, there is a continuing need to develop more readily available materials without compromising desirable characteristics. We must stop looking for an easy way out. You and I know what can be accomplished by the use of cobalt, beryllium, nickel, and the like. I imagine that some top scientist will discover new properties by reducing the degree to which these metals are used. *We must dig in and find new additives.* We must come up with something revolutionary, something that changes our entire thinking, in regard to the use of materials in air vehicles.

We all recognize the need for lightweight construction in aircraft and missiles. But just how important is it? It has been calculated that for every pound of increase in weight of engines or equipment, at least 10 additional pounds of structural weight are required to maintain the same aircraft performance characteristics. At $50 a pound, just a "ball park" figure, for the cost of airframes, this adds up. It is understandable why the use of $10 per pound titanium alloy may not actually be an expensive solution to the weight-reduction problem. Once again I must ask that we refrain from following the easy low-pressure path of complacency to achieve our goals. You can and must look for new materials. Plastics and ceramics show terrific possibilities but what are we doing about it? Whatever your answer might be, it's not enough.

Proving Reliability ASTM's Job

Reliability must be proved beyond a doubt before new materials can be introduced into a multimillion dollar weapon system. Unreliability may jeopardize the successful accomplishment of our mission and the security of our country. Proving reliability of materials is one of the jobs for the members of the American Society for Testing Materials.

A recent study regarding the impact of new materials on machine tools reflected some rather startling information. In "sculptoring" wing skins, a special-purpose machine removed 300 cu in. of 75ST aluminum alloy per minute. However, this same machine when used in a test of sculptoring one of the titanium alloys, only removed $\frac{1}{3}$ cu in. per minute. The test of high-strength alloy-steel parts being produced at reported similar low cutting-speed rates, leads to the conclusion that the machining time required to produce equivalent parts from the new materials, compared with those now being produced, from aluminum alloy, will increase in order of magnitude. . . from *5 to 300* times the aluminum machining time. As you can see, our ability to manufacture and mass-produce hardware, from the materials *under development* may be *retarded* to the point where the value of introducing them into the modern weapon cannot be justified in terms of dollars and cents. With this problem, like the high-temperature problem, and the weight-reduction problem, we must have your assistance and active participation.

Major Breakthroughs Needed

It is not enough merely to advance the "state of the art" in the materials field in step with advances in other fields of aeronautics. Materials must pace this progress. What we need are major "breakthroughs" all along the line. Without dramatic, revolutionary developments in materials we will find it difficult, if not impossible, to accomplish our mission of achieving and maintaining qualitative superiority in the air.

It is my sincere hope that information regarding our problems will find its way into your hearts and minds, and will stimulate independently sponsored research and development programs. I say this because the magnitude and urgency of military requirements have in the last few years fostered a tendency to look to the Government for the financing of most research and development, the results of which have military as well as commercial applications. If the present trend continues we are bound to reach the point where military expenditures can no longer be borne by the civilian economy without affecting our way of life. The absolute qualitative superiority needed indefinitely to insure our survival as a nation, must be bought at a price which increases at a geometric rate from year to year. Obviously, we cannot afford to jeopardize our survival. But neither can we afford to destroy economically the very way of life which we endeavor to protect militarily.

To be sure, the Soviets face a similar problem. However, they can solve it by using their dictatorial powers to funnel practically unlimited resources in men and materials, into their military effort.

Soviet Training Installations

During my recent visit to Russia in the company of our Air Force Chief of Staff, General Twining, and other United States Air Force leaders, I had an opportunity to see firsthand evidence of their ability to direct top engineers toward the furtherment of their military effort. We visited the Zhukovski Air Engineering Academy—one of a whole network of training establishments. It trains Air Force officers in the aeronautical and associated sciences over a 5½-year period.

Several things about this academy impressed us. One was the apparent high quality of the instructors. We met several of them in different specialties and it was apparent from our conversations that they were outstanding in their fields. We were also impressed by the amount of modern up-to-date equipment they made available for their student training. They used high-speed laboratory photography of over 2 million frames per second, for ballistics studies, and a great amount of advanced apparatus for teaching metallurgy. For the testing of materials, spectro-analysis and other such advanced techniques were normal. The most unexpected facility we encountered was the wind tunnels, one of which operated at Mach 3 and another which they said could produce Mach 5 conditions. Of course, we have many wind tunnels of this capacity in the United States; however, this was surprising equipment for a training installation.

It was quite apparent that their scientific efforts were not suffering from lack of resources. When asked questions regarding their budget, they were unable to understand exactly what we meant. The Soviets have the ability to direct their top scientists and engineers to whatever program they desire. For the most part, this means to their military effort. They discard competition and project similarity. The importance of any given project dictates the caliber of professional personnel assigned. I do not wish to leave the impression that the Soviets have unlimited resources, but there appears to be no stinting once a national decision has been reached to go ahead with a project. Their standard of living is based on what is left over from directed programs.

Unique Advantages in a Free Economy

I firmly believe that we can solve our problems better by utilizing advantages which are unique to a free economy such as ours. Foremost among these advantages is the incentive created by free competition in the world's largest and most prosperous consumer market.

Private research and development is a good investment in this country because it can produce not only well-deserved financial gains, but can also contribute to the military position of the nation. Thus, private research and development can serve a double purpose, by benefiting the individual both as an investor and as a citizen. Additionally, private research and development foster a freer competitive atmosphere. From a purely commercial or civilian viewpoint, we compete among ourselves. From a military viewpoint, we compete with and attempt to surpass our potential enemies. Also, and this is important, we compete with our allies. Some of our allies are already ahead of us in the field of jet transportation, but we will catch up. In fact, we will advance them by a few years. The transports that Boeing, Douglas, Convair, and Lockheed are tooling up to produce will be far superior to those now in existence—and this is just the beginning. The road is being paved for supersonic transports and, following that, for nuclear transports. Imagine flying around the world, nonstop, in 24 hr or less: Los Angeles to New York in a couple of hours—just one good cigar smoke away.

As a point of interest, private industry is already viewing with an eager eye the coming of small jet aircraft. To the VIP's of our Government and our big industrial concerns, the importance of time is supreme. A good friend of mine, the president of one of our larger companies, insists that his time is worth $20,000 an hour to his company. At that rate, the difference between 2 and 8 hr across the country is important. He can't afford to wait for an airline going his way. When he's ready to move he should have his own jet standing by, ready for take-off.

The assumption of a greater share of the research and development burden by science and industry would also help us in coping with another and equally serious problem—reduction of the time cycle required for the development of advanced weapon systems. The combined knowledge and talents of the many thousands of competent specialists in private enterprise throughout the country represent a technological asset that the Soviets will find difficult to match. Our combined efforts in solving the pressing problems in this field is of vital importance to all of us. Our future depends on what we do today to strengthen tomorrow's airpower.

The Important Factor

I have one final and most important point, so important, in fact, that if we fail in it we shall surely fail in all our future scientific endeavors. That is in regard to developing, training, and motivating young scientists and engineers to continue with and to improve upon, the technological advances we have so far accomplished. Every experiment you conduct, every process you develop, and almost every idea that you convert to testing methods and equipment, anticipates in some degree the future capabilities of young men and women now in school. Many of these young citizens are uncertain of their life-work plans. In comparison to the young Soviet manpower pool, too few of them are aiming toward scientific and technical careers and professions.

It behooves each and every one of us to give active and enthusiastic support to any effort—educational, governmental, or industrial—that tends to encourage, advise, or induce young Americans into these critical skill fields. Unless we do so there is no assurance that our current rate of progress will continue to be successfully projected into the years ahead. Over 25 per cent of the people in this great country of ours are in school. We must inspire and motivate these young men and women to pursue those studies which will enhance their ability to participate effectively in the brave new horizons of the future. In this way, their future and the future of our country will continue to advance the cause of freedom.

In closing—my purpose has been to remind you of the challenges that lie before us and to solicit your vigorous participation in meeting them. You materials folks must get ahead and stay ahead of our hardware designers. You must develop testing and acceptance equipment to prove the value and reliability of the new materials. You must develop better manufacturing methods and procedures, more precise manufacturing and production standards.

You can deliver the goods provided you reject the course of complacency, accept the responsibility, and exert your fullest capacities toward solutions to the problems just outlined.

I am convinced that the American Society for Testing Materials will pioneer as they always have in unlocking the doors to scientific progress—thus assuring that the free people of our great country will provide the leadership to make this world of ours a better environment for our children.

ASTM Bulletin

DECEMBER 1956

NO. 218

NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

1956 Membership Sets Record High

Thanks to All Who Aided in Bringing in 1000 Members

As THIS issue goes to press the total membership of the Society is just over 8600. More than 1000 new members have been elected in the current calendar year, topping last year's record by 225. The Committee on Membership and the entire Board of Directors appreciate the efforts of all who contributed toward this gratifying result.

Always, the current membership has been one of the main sources of new members. The acquisition of new affiliates through individual and committee interest is an important factor in maintaining vigorous membership growth.

In noting the favorable aspects of the 1956 membership picture it is significant to record that there was consistent growth in all classes: Individual, Company, Sustaining, and Associate.

Associate Class Thriving

The new Associate class (extending age limit of the former Junior group to 30 years) got off to a good start in its first year, with some 90 new Associates enrolled as of November 20. Designed to bring in more young members in all fields, and specifically to stimulate interest on the part of the young engineering faculty man, the Associate class promises to be an effective tool in accomplishing this dual purpose.

ASTM Sustaining Membership

The Sustaining class, with its very liberal publication benefits, continues to attract many companies and associations. At the same time through annual dues of $150 it aids substantially in underwriting the work of the Society. (List of those *recently* joining the Sustaining group now totaling 379, appears in the box. Others are planning to transfer to Sustaining as of January, 1957.)

The committee on Membership again asks that each ASTM member continue to be alert to opportunities to present the advantages of membership to both individuals and companies, and to stress that new members can contribute to the Society's research and standardization work.

The Committee further recognizes the intensive cooperative efforts, particularly in 1956, of many of the technical committees and District Councils in making ASTM more widely known in their respective technical and geographic areas and bespeaks continuance of these commendable endeavors. It is interesting to observe that certain of the more recently organized groups have been most enthusiastic and energetic in enlisting prospective members.

NEW SUSTAINING MEMBERS

Atlantic Coast Line R.R. Co.
Bird and Son, Inc.
Cast Iron Pipe Research Assn.
Cities Service Petroleum, Inc.
Evans Products Co.
Fairbanks Co., The
Harbison-Walker Refractories Co.
Interelectric Corp.
King & Gavaris
Oak Ridge National Laboratory
Pennsylvania Forge Co.
Pennsylvania Power & Light Co.
Polymer Chemicals Div., W. R. Grace and Company
St. Louis-San Francisco Railway
Silicones Div., Union Carbide and Carbon Corp.

It is hoped that all will continue to pass the word along. ASTM *is* an organization distinctive in its activities and worthy of hearty recommendation—and from the standpoint of publications offered on the various classes, *membership* is a *most practicable* way of keeping informed regularly of research and standardization developments in materials in the diverse fields in which the Society functions.

Why not keep a supply of membership literature and application forms at hand? Headquarters will be glad to send a folder about the Society giving general information on membership benefits, also the Sustaining Membership brochure.

Student Membership

Largely as a result of the Student Membership Prize Awards we have had a good influx of engineering students. Information has been given in the BULLETIN concerning the interest of various District Councils in underwriting these awards which range in number from 10 to 180, the latter figure tieing in with the very great interest in the award plan in the Southwest District. The Directors feel that Student Membership is very desirable, giving the future engineer in his undergraduate days the knowledge of what ASTM stands for and some data on what it is doing, at the same time furnishing him helpful information on materials.

Headquarters will gladly send further details on request to members interested in sponsoring Student Membership Prize Awards at their alma mater.

Technical Secretary Speaks on Standardization at Johns-Hopkins

FOR THE fifth consecutive year, ASTM's Technical Secretary, R. E. Hess, has been invited to present a talk at Johns Hopkins University covering the methods followed in arriving at standards. This talk is given in connection with a course on business management conducted by William Passano of Waverly Press.

Standards are referred to in the course as having an important place in business management, and the part played by the technical societies, and others, in the preparation of standards is mentioned. An excellent opportunity is provided to present the workings of ASTM and similar organizations.

1957 Nominating Committee

In accordance with the Bylaws of the Society, which provide that the Board of Directors shall select a nominating committee for officers, the Board has considered the report of the tellers—E. M. Redstreake and F. P. Spruance—recommending members of the nominating committee, and has appointed the members shown below. Serving on the 1957 Nominating Committee as *ex officio* members are the three immediate past-presidents: L. C. Beard, Jr., N. L. Mochel, and C. H. Fellows. The committee will meet in February and will nominate for the offices of President, Vice-President, and five Directors. Their selections will be announced in the ASTM Bulletin prior to transmission of the official ballots.

Members	Alternates
J. G. Morrow, Steel Co. of Canada	E. S. Steigner, Youngstown Sheet and Tube Co.
A. W. Carpenter (retired)	S. Collier, Johns-Manville Corp.
W. H. Lutz, Pratt & Lambert, Inc.	L. T. Work, consultant
H. W. Stuart, U. S. Pipe and Foundry Co.	D. L. Colwell, Apex Smelting Co.
C. A. Neusbaum, Esso Research and Engineering Co.	J. B. Rather, Jr., Socony-Mobil Oil Co.
C. F. Graham, Wyandotte Chemical Corp.	R. B. Crepps, Divens-Corning Fiberglas Corp.

Schedule of ASTM Meetings

This gives the latest information available at ASTM Headquarters. Direct mail notices of all district and committee meetings customarily distributed by the officers of the respective groups should be the final source of information on dates and location of meetings. This schedule does not attempt to list all meetings of smaller sections and subgroups.

Date	Group	Place
January 21-23	Committee A-1 on Steel	Houston, Tex. (Rice Hotel)
January 22	Joint Meeting—St. Louis District and Missouri Society of Professional Engineers	St. Louis, Mo.
January 21-23	Committee D-19 on Industrial Water	Charleston, S. C. (Ft. Sumter Hotel)
January 31–February 1	Committee F-1 on Materials for Electron Tubes and Semiconductor Devices	Washington, D. C. (Mayflower Hotel)
February 4-8	**Committee Week**	**Philadelphia, Pa. (Benj. Franklin Hotel)**
February 10-16	Committee D-2 on Petroleum Products and Lubricants	New Orleans, La. (Jung Hotel)
February 11	Northern California District	San Francisco, Calif.
February 12	Southern California District	Los Angeles, Calif.
February 15	Southwest District	New Orleans, La.
February 21	Southwest District	Dallas, Tex.
February 18-20	Joint ASTM-TAPPI Committee on Petroleum Wax	New York, N. Y. (Commodore Hotel)
February 20-22	Committee D-1 on Paint, Varnish, Lacquer and Related Products	Washington, D. C. (Shoreham)
February 21-22	Committee D-6 on Paper and Paper Products	New York, N. Y. (ASA Headquarters)
February 25-27	Committee D-9 on Electrical Insulating Materials	Roanoke, Va. (Hotel Roanoke)
February 27–March 1	Committee D-20 on Plastics	Roanoke, Va. (Hotel Roanoke)
March 5	Committee E-12 on Appearance	New York, N. Y.
March 19-22	Committee D-13 on Textile Materials	New York, N. Y.
April 25-26	Committee D-15 on Engine Antifreezes	Washington, D. C. (Shoreham Hotel)
May 2	Committee C-20 on Acoustical Materials	New York, N. Y. (ASA Headquarters)
May 20-24	Committee E-14 on Absorption Spectroscopy	New York, N. Y. (Commodore Hotel)
June 16-21	**Annual Meeting**	**Atlantic City, N. J. (Chalfonte-Haddon Hall)**

West Coast Meeting Papers

Upward of 200 papers were presented at the Pacific Area National Meeting as indicated in the Provisional Program distributed to the members some time ago. Many of these were presented as parts of symposiums or well integrated sessions and will lend themselves to publication in special technical publications (*STP*'s). The review of these papers looking toward such publication is now taking place. Announcements will appear from time to time concerning availability of these publications.

Some few of the papers will be published in the ASTM Bulletin and other Society publications; others are being released for publication elsewhere.

Most of the papers were duplicated, that copies might be available at the meeting to promote discussion. A supply of some of these still remains and is available for general distribution as long as the supply lasts. A charge of 50 cents per copy covers the cost of handling.

1957 Award of Merit Committee

The 1957 Award of Merit Committee, appointed by the Board of Directors, includes Henry Grinsfelder and F. H. Pennell, serving with holdover members M. A. Swayze, Chairman, and B. A. Anderton. C. H. Fellows will represent the Board of Directors on the Committee. In accordance with Rules Governing Award of Merit (p. 625, 1956 ASTM Year Book), all suggestions for 1957 Awards must be in the hands of the Executive Secretary of the Society for consideration by the Award of Merit Committee not later than Feb. 1, 1957.

1956 Year Book Distributed

The 1956 ASTM Year Book, put in the mails in November, was sent to those who returned the shipping label. This label was attached to the notice sent to all members indicating that the Year Book would be distributed *only on request*. If your requested Year Book has not yet reached you, kindly advise Headquarters.

Correction

Attention is called to an incorrect statement made in the reference to papers presented by Prof. R. K. Bernhard, Rutgers University, as part of the Soils Sessions at the Second Pacific Area National Meeting in the October issue, page 14.

The statement should have read: Prof. R. K. Bernhard, Rutgers University, has been associated with dynamic properties of soils for a number of years. In his latest contribution he discussed the progress made to date in the determination of basic soil characteristics by means of sinusoidal force excitation producing various types of propagation waves. He referred to these investigations as microseismic studies.

District Activities

President Schatzel Honored at Home-Town Meeting in Rome

Speaks on Materials for Power Distribution

THE PRESIDENT of the Society, Dr. R. A. Schatzel, was the guest of honor and also the chief speaker at a meeting in Rome, N. Y., on November 19 which was sponsored jointly by the Rome-Utica Chapter of the American Society for Metals and ASTM. The Rome Cable Corp. of which President Schatzel is vice-president and director of engineering, was the cocktail host through the courtesy of Rome Cable's President, Ross Fraser, longtime associate of Dr. Schatzel. Mr. Fraser presided at the dinner.

At the Rome meeting honoring R. A. Schatzel were, left to right: Ross Fraser, president of Rome Cable Corp., W. C. Neagley, chairman, ASM Rome chapter; and President Schatzel.

Preceding Dr. Schatzel's address was a short talk by Executive Secretary Robert J. Painter, who brought greetings to the President from the Directors and Headquarters Staff. He outlined some of the ASTM President's increasing responsibilities as the work of the Society grows, touching on Government contacts, financial matters, growing membership, relations with other societies and associations, and district activities. The latter involve considerable traveling on the President's part to speak at meetings sponsored by the various councils. In a brief discussion on standards in industry Mr. Painter stressed the interdependent relationship of research and standards. To develop satisfactory standards, both tests and specifications, the technical committees need the latest data on materials, much of which must come from research work. In order to evaluate the results of research there must be standards of comparison, and this requires recognized and reproducible tests. Industry is giving fine support to the ASTM standardization program directly and by carrying out much needed research.

Standardization is one of the elements of teamwork which a leading industrialist has described as the greatest invention of our times—agreement by teamwork.

Materials for Power

In his address, President Schatzel traced the development of channels of power transmission from Edison's jute-wrapped copper rod in an asphalt filled pump log to the huge cables which today carry as high as 380,000 v.

ASTM specifications and methods of test are widely used in materials of all three components of wire and cable—conductor, insulation, and protective covering. Wire and cable must be designed having use, space, and environmental requirements in mind. Lead, as a protective covering of the conductor and insulation parts, is still the most widely used material for this purpose.

Of the four electrolytically refined coppers used in conductors, the ones most commonly used are the electrolytic tough pitch types—which contain absorbed oxygen in the form of copper oxide, and oxygen-free copper poured in an inert atmosphere to eliminate all oxygen absorption. High-purity aluminum, to be as effective a conductor as copper bar, requires 75 per cent more space.

Requirements of electrical and physical properties and design determine selection of insulating materials. High-polymer rubbers are most widely used; silicone rubber has raised operating temperatures so high that in time the conductor rather than the insulation may become the limiting factor in application. World War II accelerated use of the plastic, polyethylene, most of which went into radar equipment, and polyvinyl chloride, now the most commonly used plastic for insulation.

With the great variety of materials for these purposes made available to the industry by the metallurgist and chemist, Dr. Schatzel pointed out that chaos would result if industry did not have standards such as ASTM develops to guide the engineer.

Local arrangements for the meeting were handled by Robert Graham, chief engineer, Rome Cable Corp. Gus Pirk was chairman of the Program Committee, and William C. Neagley, Chicago Pneumatic Tool Co., chairman of the ASM Rome Chapter, presided at the technical session.

SOUTHERN CALIFORNIA

What Keeps Metals from Corroding Faster?

QUITE a number of ASTM members attending the Second Pacific Area National Meeting at Los Angeles took a busman's holiday on September 20, to hear ASTM Director Frank L. LaQue speak on "What Keeps Metals from Corroding Faster?" at a joint meeting of the American Society for Metals, ASTM Southern California District, and the National Association of Corrosion Engineers. There was great interest in the subject and the meeting drew an unusually large attendance.

Mr. LaQue, vice-president and manager, Development and Research Div., The International Nickel Co., pointed out that the basic cause of corrosion is the instability of metals in their refined forms and that reactions that lead to common corrosion products are spontaneous and theoretically should proceed at rates much higher than those commonly observed. This is especially true of such metals as aluminum, magnesium, chromium, and titanium at the upper end of the electromotive series.

Mr. LaQue reviewed several factors that slow down the theoretically possible rates of corrosion and indicated how to take advantage of them in making metals

last longer in corrosive environments. The deep interest in Mr. LaQue's subject was evidenced in the vigorous discussion which followed his talk.

NEW ENGLAND

Forgings' Special Problems Described by Schaefer

THE New England District of ASTM, meeting jointly with local chapters of the Society for Nondestructive Testing, American Society for Metals, and the National Association of Corrosion Engineers, at the Commander Hotel in Cambridge, Mass., heard A. O. Schaefer, vice-president and director of research of the Midvale Heppenstall Co., Philadelphia, speak on "Manufacture and Testing of Large Forgings." About 100 members and guests attended the dinner meeting.

Mr. Schaefer, an excellent speaker, presented his subject in a friendly narrative manner, making it interesting for his listeners who are not primarily metallurgists as well as those who are. Discussing the principles of the manufacture of large forgings, he pointed out the difference in thinking and in practice for this product which accounts for a very small percentage of the total steel tonnage when compared with the manufacture of other steel products. Mr. Schaefer emphasized the custom-made character of forgings and reviewed problems of ingot design, selection of chemical composition, and forging practice. He discussed the relation of inspection and testing techniques to failure problems at considerable length, and also mentioned the fields in which fundamental research is needed.

CHICAGO

Materials in 1976

ONE of the most unusual District Meetings held recently was a symposium sponsored by the Chicago District, on October 16. The panel, in an afternoon meeting before an audience of nearly 80, discussed "Predictions of Materials and Their Uses in 1976 and the Role of ASTM." Four speakers gave a peek into the future and described things to come.

J. J. Kanter, directing engineer, Engineering Laboratories, Crane Co., discussed the future trends in metals; R. H. Bruce, sales manager, molding materials, Bakelite Corp., gave a picture of the future for plastics and what can be expected of this material; portland cement's place as a construction material of the future was outlined by ASTM Director A. Allen Bates, vice-president, research and development, Portland Cement Assn. Rounding out the panel was Carl H. Samans, director of engineering materials, Standard Oil Company of Indiana, who spoke on the future of petroleum products. The meeting was held at the Western Society of Engineers Building in Chicago.

ST. LOUIS

Modern Steels and Their Weldability

WITH the introduction of new quenched-and-tempered high-strength alloy steels, many interesting properties of these metals have been discovered. W. D. Doty, research engineer for welding at the Applied Research Laboratory of the United States Steel Corp., discussed many of these newly discovered properties at the Engineers Club of St. Louis on October 11. In addition, he also described the broad spectrum of welding techniques as applied to steels.

The meeting was held jointly with American Welding Society and Engineers Club of St. Louis.

PITTSBURGH

AEC's Goodman Sees Future of Economic Nuclear Power Depending on Materials People

"...I am sure you will agree that the future of economic nuclear power rests more in the hands and minds of you materials people than with any other single technical group." So concluded Clark D. Goodman, assistant director, Division of Reactor Development, United States Atomic Energy Commission, in his talk before a joint meeting of the Pittsburgh District of ASTM and the Pittsburgh Nuclear Activities Council, on October 30.

Following his talk, "Nuclear Materials—the Bottleneck," the group held a lively discussion centering on the effects of radiation on materials.

Dr. Goodman cited examples of the work going on in the selection of reactor moderators, stressing the need for research to develop economic materials that can be used in this work. He went on to discuss various types of reactors and the economic and technical problems associated with them. One of the major problems faced in nuclear energy is in the field of testing.

"...tests not yet started will be required to determine how well these materials problems are affected by radiation" Dr. Goodman said. The Materials Testing Reactor at the National Reactor Testing Station in Idaho is used for just such purposes. Those who have visited the MTR or know about its use will appreciate the amount of expensive time-consuming test work that is required to prove out any new reactor concept. Some of the individual test loops and measuring instruments require a year for design, construction, and installation. Some cost upward of a half million dollars per loop.

"In view of the extensive radiation testing required, it is not surprising that the MTR which began operation in 1952 gradually filled up as experiments were developed and has been filled to capacity for the last two years.

"Besides taking steps to increase its capacity and to improve the speed of testing, we are now building an Engineering Test Reactor (ETR) for the testing of more and larger components. The various prototype reactors also provide test data on the materials used in their construction."

Dr. Goodman was introduced by E. M. Kipp, Vice-Chairman of the Pittsburgh District, who also conducted the discussion session.

NEW YORK

Flame Plating—New Method for Building Wear Resistance

WITH the aid of a technical film, J. R. Craig, eastern manager, flame plating, Linde Air Products Co., described a new and spectacular method of coating metals with wear-resisting carbide or aluminum oxide at a joint meeting in New York City of the ASTM New York District, The American Society of Mechanical Engineers, and the American Society of Tool Engineers. The meeting was held Friday evening, November 16, at the Engineering Societies Building.

The method of flame plating uses a gun which develops a detonation within its barrel that propels particles of tungsten carbide or aluminum oxide out at the rate of three times the speed of sound. The pressure in the barrel of the gun reaches 10,000 psi and the temperature an estimated 9000 F. So intense are the shock waves produced when the gun is fired that all flame plating is done in a room with 3 ft. thick concrete walls, double steel doors, and control room windows composed of seven layers of laminated glass. The gun is fired by remote control.

Mr. Craig described the process used in flame plating as the impinging of incandescent tungsten carbide or aluminum oxide on metal surfaces requiring long life wear resistance. The particles

of carbide or aluminum oxide, approximately 40 microns in diameter, are propelled by inert gases into the barrel of the gun which is water cooled to keep it intact. In the barrel a premixed mixture of oxygen and acetylene under detonation carries the powder out against the part that is to be flame plated.

Although the particles are in an incandescent state, the parts to which they are applied seldom reach 400 F. As the gun continues to fire, layer after layer of either carbide or aluminum oxide is built up to the desired thickness. Coatings from 0.001 to 0.040 in. can be obtained. Usually some excess is applied and the precise size is then obtained by grinding on diamond wheels that are flood cooled.

Parts designed to come in contact with abrasive materials at temperatures below 800 F can be coated with tungsten carbide. Above this temperature, aluminum oxide is used to a maximum of 1400 F. Where abrasiveness must be resisted, the flame plated parts have lives of 3 to 60 times that of conventional sintered carbide coatings. The porosity of flame plated coatings is somewhat less than that of conventional coatings.

Mr. Craig completed his lecture with a showing of some practical applications on bearings, coating tools, piston parts, and parts designed to resist galling. Two important points brought out during the lecture were that flame plating cannot be applied to edges nor into blind holes. Flame plating of blind holes is impossible because the material entering the hole ricochets and prevents the following particles from entering.

Mr. Craig was introduced by Harold Carlson, Program Chairman. Introductory remarks were also made by C. P. Pitman, Chairman of the ASTM New York District.

OFFERS OF PAPERS FOR 1957

THE Administrative Committee on Papers and Publications will meet in early February to consider the papers to be published by the Society in 1957 and to develop the program for the Annual Meeting to be held in Atlantic City, N. J., June 16–21.

All those who wish to offer papers for presentation at the meeting and publication by the Society should send these offers to Headquarters *not later than January 10, 1957.*

All offers should be accompanied by a summary which will make clear the intended scope of the paper and will indicate features of the work that will, in the author's opinion, justify its publication and inclusion in the Annual Meeting program.

Suitable blanks for use in transmitting this information will be sent promptly upon request to Headquarters.

New Lab for NCMA

A FIVE-acre tract of land has been purchased by the National Concrete Masonry Assn. as the site for a proposed laboratory and office building, located in West Chicago, Ill., 29 miles directly west of downtown Chicago. Plans call for 6000 sq ft of laboratory space and 4000 sq ft of office space, in the one-story structure.

Although the laboratory will be small in comparison with others devoted to industrial research, it will be the largest and most adequate given exclusively to research in concrete masonry.

Gray Iron and Nodular Iron Specifications Summarized

ASTM Specifications figure prominently in a Summary of Specifications for Gray Cast Irons and Nodular Cast Irons prepared by Gray Iron Founders' Society, Inc.

The summary covers the more commonly used specifications; including primarily mechanical properties and chemical composition where specified, but does not present all details of the specifications. Standards, such as methods of tests, recommended practices, and definitions, are given in a supplementary list.

Copies of the Summary can be obtained from Gray Iron Founders' Society, Inc., National City–East Sixth Bldg., Cleveland, Ohio.

Materials in the Automobile of the Future

A SHORTENED version of A. L. Boegehold's talk before the ASTM Cleveland District in April, 1956, has been published in the September, 1956 issue of *Metal Progress.* In this talk, Mr. Boegehold, manager of research staff activities of General Motors Corp., made the following conclusions:

1. Engine and car weights are going down.
2. Engine efficiency will increase.
3. We will use light alloys generously to supplement increased efficiency as a means of conserving fuel.
4. Otherwise, materials will be much the same as now but with less nickel and with more pearlitic malleable iron.
5. The power plant used in the future will have low weight and low volume per horsepower, and will have good fuel economy.

To ASTM Members: Your help is needed in maintaining that constant increase in ASTM Membership

To the ASTM Committee on Membership,

1916 Race St., Philadelphia 3, Pa.

Gentlemen:

Please send information on membership to the company or individual indicated below:

_____

_____

This company or individual is interested in the following subjects: indicate field of activity, that is, petroleum, steels, non-ferrous, etc.

_____

Signed _____

Date _____ **Address** _____

ADMINISTRATIVE COMMITTEE ON RESEARCH

R/D First—Then Standardize

IT IS well recognized in the ASTM technical committees that in order to devise a meaningful test method suitable for publication in the ASTM Book of Standards it is necessary, first, to have a rather thorough understanding of the nature and basic properties of the material in question. A standard is like the part of an iceberg that is above water—the nine-tenths or so that does not show corresponds to the research effort backing up the standard. So ASTM is a research Society and a standardizing society, as well. It is because of this Society-wide stake in research that the Administrative Committee on Research was organized in 1924—to consider means by which the work of the Society in promoting knowledge of engineering materials may best be advanced; to encourage and stimulate investigations for this purpose under the auspices of the Society; to seek to bring about studies of those properties of materials concerning which information is needed; and to review annually the progress of the Society's research activities.

Symposium Planned

At its meeting at Headquarters on October 31, the Administrative Committee on Research took action on a number of items of interest to the Society. Plans were laid for a symposium on research to be held at the 1958 Annual Meeting of the Society in Boston. W. J. Smith of Arthur D. Little is chairman of the Symposium Committee. The committee reviewed some of the major research projects supported by technical committees of the Society through solicitation of funds from industry. Projects reviewed included those of the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals (BULLETIN No. 212, February, 1956, p. 23); the Joint Committee on Chemical Analysis by Powder Diffraction Methods; the project on the effect of moisture on the performance of thermal insulation under the auspices of Committee C-16 on Thermal Insulating Materials; the Wood Pile Research Porgram supported by Committee D-7 on Wood; a project at the U. S. Forest Products Laboratories to develop a tunnel fire test sponsored by Committee E-5 on Fire Tests on Materials and Construction; and the work of the Advisory Committee on Corrosion. Funds appropriated for the above projects to date exceed a half-million dollars.

The committee contributes the ACR Notes Column in each issue of the BULLETIN, the members taking turns as contributors. This column which has appeared in each issue of the BULLETIN since April 1954 is in the nature of signed editorials on which comments are invited.

Unsolved Problems

The committee sponsors a project to compile and disseminate information on "Challenges in Materials Research" of concern to the technical committees. "Challenges in Materials Research" is the new title for the "Unsolved Problems" project, co-sponsored by the Administrative Committee on Research with the technical committees, of the Society. Dissemination of these problems has elicited widespread interest. The committee believes that through wide dissemination, research on problems of interest to ASTM will be stimulated both in industry and the universities.

The committee approved a proposal of A. T. McPherson for tapping a new source of research and testing potential in the universities—undergraduates who are taking courses in engineering materials (ACR Notes, BULLETIN No. 217, October, 1956, p. 31). Efforts toward implementing the proposal are going forward.

The committee has available for contributions to research projects, a Research Fund amounting to about $73,000, which provides an income of about $3000 a year. Contributions from this Fund are appropriated by the committee on request from the technical committees of the Society if, in the opinion of the committee, the project will advance the interests of the Society. At the October 31 meeting the committee approved a contribution of $500 to the research program carried out cooperatively by the American Electroplaters' Society which is of direct interest to ASTM Committee B-8 on Electrodeposited Metallic Coatings.

The committee urges that each technical committee of the Society include a report on research in its Annual Report. Other subjects considered by the Administrative Committee on Research included a report of liaison with the National Research Council by Bruce Gonser, chairman of the committee, and ASTM representative on the NRC Division of Engineering and Industrial Research. Also, the committee discussed briefly the work of the Engineering Foundation in supporting cooperative research and surveys and articles on cooperative research by the National Science Foundation and the American Chemical Society.

To ASTM Nonmembers: The Society welcomes inquiries on the "Advantages of Membership"

To the ASTM Committee on Membership
1916 Race St., Philadelphia 3, Pa.

Gentlemen:

Please send me information on Membership in ASTM and include a membership application blank.

Signed _____

Address _____

Date _____

Technical Committee Notes

Work on Sorptive Mineral Materials Begun

MATERIALS used for surface maintenance and safety will be included in the scope of a new ASTM technical committee in the process of organization. The field of coverage for the present will be limited to sorptive mineral materials. The new activity is an outgrowth of requests from industry for standard procedures for testing granular floor absorbent materials; for example, those containing, fuller's earth.

A well-attended conference was held in January of this year to discuss the need for standards in this and related fields. Following an informative discussion of the various problems which might be encountered it was the consensus of the conference that a new ASTM technical committee should be formed to develop standards for sorptive mineral materials. The proposed scope is as follows:

The definition of terms and the formulation of test methods covering mineral sorptive materials used for surface maintenance and safety and the stimulation of research to accomplish the foregoing purposes.

A steering committee, formed at the time of the conference, has laid plans for an organizational meeting of the new committee, authorized by the Board of Directors at its May meeting. The proposed committee will consist of subcommittees on definitions, sampling and test methods, recommended practice, and an executive subcommittee. The organization meeting will be held during the 1957 ASTM Committee Week, Feb. 4–8, in Philadelphia, Pa.

Additional members, especially from consumer interests, are still being solicited to make representation as complete as possible. Organizations interested in the development of standards in this field should make inquiry at ASTM Headquarters for further information. An invitation is also extended to attend the organizational meeting.

Electrodeposited Metallic Coatings

Exposure Tests Questioned in Evaluating Chromate-Treated Panels

COLORED slides shown to Committee B-8 at its October meeting revealed that 3 years of inside and outdoor exposure of chromate-treated zinc panels showed no striking difference in the corrosion of the panels regardless of the mode of plating. Preliminary conclusions indicate that exposure tests offer little promise as a method of evaluating chromate-treated panels.

There is a strong feeling that significant information can be obtained on the effect of phosphate coatings on the adhesion of organic films. For this study 60 panels using a high-quality vinyl system, as well as a comparable alkyd system would be subjected to outdoor exposure, salt-spray testing, adhesion measurements, and possibly a study of the crystal structure by X-ray diffraction techniques.

A proposed specification for electrodeposited coatings of nickel and chromium on steel for engineering use, where protection against corrosion or against wear, abrasion, or erosion of the basis metal is important, was reviewed in subcommittee.

Two proposed recommended practices presented for committee ballot are for cleaning prior to electroplating, and preparation of malleable, gray iron, nodular iron, spheroidal iron, and white iron castings for electroplating.

The committee also reviewed the progress of work on double-nickel undercoat for chromium, organic coatings on chromium plate, use of industrial water for electroplating, a proposed more definitive numbering system for appearance rating, the solderability of tin-alloy plating, a ductility test of electrodeposited coatings, and a survey of chromium plate thicknesses utilized for decorative and industrial uses.

Thermal Insulating Materials

Standardization Work on Foamed Plastics for Insulation Begun

FOAMED plastics—a new type of thermal insulating material which is growing in use—can be employed in two ways: as a preformed product, or foamed-in place. Development of specifications and test methods for both types has been started in Committee C-16. Coordination of this work will be required with other committees in the Society, particularly Committee D-20 on Plastics. The Coordinating Committee on Cellular Materials will function as liaison.

Other accomplishments reported at the October meeting in Williamsburg, Va., were acceptance for letter ballot of complete revisions of the Specifications for Mineral Wool, Molded-Type Pipe Insulation for Elevated Temperatures (C 281) and Mineral Wool Molded-Type Pipe Insulation for Low Temperatures (C 300); a new Recommended Practice for Prefabrication of Insulation Covers for Fittings, Flanges, and Valves; Test Methods for Consistency of Wet-Mixed Insulating Cements; Specification for Batt and Blanket Type Insulation for Buildings; and a Method for Sampling of Preformed Insulation. The recommendations in a final task-group report on handleability of block-insulating materials include equipment and test procedure for consideration as a standard method of measuring the resistance to breakage, an index to be established for the acceptance of block insulation, and a list of indices for each type of material, based on 80 per cent of the samples tested with a minimum of five samples considered.

Among the test methods being developed to cover special thermal properties are emissivity, hot-surface performance, mechanical stability by abrasion, and fire resistance. An additional test method to cover low-temperature conditions using the Wilkes Calorimeter apparatus has been drafted and consideration is also being given to determination of thermal conductivity of reflective insulation which may require special methods.

Additional coverage in the field of structural insulation board standards is now being considered in the current development of specifications and methods

of test for insulating roof deck slabs and for structural insulating formboard.

Definitions which are needed to guide the activities of the relatively new Subcommittee on Reflective Insulation—covering industrial reflective insulation and reflective building insulation—were agreed upon by the subcommittee.

A final report was submitted by the Task Group on Research on work on the effect of moisture on thermal conductivity at Pennsylvania State University. All funds have now been expended and though the report indicated that additional fields of research were desirable, the probe method was recommended as a useful tool in studying the effect of moisture and in a laboratory test on wet insulation. Further research was suggested in the study of moisture migration.

A dinner, attended by over 100 members and guests, honored retiring Chairman Elmer R. Queer, assistant director of the Penn State Engineering Experiment Station.

For complete details of the technical sessions Committee C-16 will sponsor during 1957 Committee Week, see page 6.

Acoustical Materials

First Draft of Reverberation Room Method for Sound Absorption

An important milestone in the development of standard procedures for measuring sound absorption was reached at the October 9 meeting of Committee C-20 in Chicago, Ill. The first attempt to draft a standard method for the measurement of sound absorption in reverberation rooms has been made in the form of a proposed method which was circulated and reviewed in the Subcommittee on Sound Absorption. The scope of this method will include all materials used as acoustical ceilings or wall treatments as well as separate objects such as space absorbers and theater chairs. As a result of the consideration by the subcommittee, a second draft will now be prepared for consideration at the next meeting.

Further round-robin tests were planned to check uniformity results using the impedance tube method, recently adopted as an ASTM tentative (C 384), particularly to check the variation in small size specimens cut from the larger 12 by 12-in. pieces. The test will emphasize the use of types of boards that are more of an unusual nature, in order to verify the flexibility of the test method. The use of the horn coupler device for the impedance tube will be tested at three different laboratories including the National Bureau of Standards. The results of these tests may lead to a revision of the impedance tube method. A draft of a third method, known as the box method, will be completed by the time of the next meeting.

A round-robin test program has been arranged to check the reproducibility of a proposed method of flame-resistance classification of acoustical materials before submittal to letter ballot of Committee C-20. This proposed method is a modification of the method used in the Federal Specification SS-A-118b. The Subcommittee on Flame Resistance is following the developmental work in connection with the small-scale tunnel test apparatus at the Forest Products Laboratory and a radiant-panel test apparatus now being studied at the National Bureau of Standards. It was reported that the large tunnel test equipment conforming to the requirements of ASTM Method E 84 has been completed at the Southwest Research Inst. and that this equipment is also in operation at the Underwriters Laboratory of Canada and the Philip Carey Manufacturing Co.

A research project at the National Bureau of Standards on the effect of soiling and painting of acoustical tile was reported at a standstill due to the exhaustion of funds. This project has been sponsored by the Public Building Service and the Acoustical Manufacturers Assn. A further grant from the Public Building Service is being solicited to complete this project. The National Paint and Varnish Assn. is also participating in the paintability tests in which seven types of paint are being tested in both brush and spray application. It is hoped that from this work a test method for determining the susceptibility of acoustical tile to soiling will be developed.

Following considerable study and work on the part of a special task group of the Subcommittee on Application a proposed specification for adhesives for use in the application of acoustical tile was presented to the committee and accepted for letter ballot. This specification will be under the joint jurisdiction of Committee C-20 and Committee D-14 on Adhesives. Hesitancy in the presentation of this specification for approval has been due to concern over the lack of a suitable accelerated aging test. However it was decided to promulgate this specification as an ASTM tentative in order to encourage its use and further improvement. A suitable note will be included calling attention to the limitations of the aging test requirements. It was also decided to include in an appendix a statement emphasizing the need for proper preparation and application.

Another phase of application considered by the subcommittee was the need for standards for mechanical suspension systems. A task group was organized to explore the various systems and determine what tests are needed, including all types of application other than adhesives. A second task group will study existing standards on application to determine their suitability for acoustical materials, for example, the American Standard Specifications for Gypsum Plastering (A42.1).

The Baumgartner sphere apparatus for light reflectance is still being studied by the Subcommittee on Basic Physical Properties as an instrument for use in the testing of acoustical tile. Further contacts with optical people will be made in an attempt to explain discrepancies in the readings of this instrument. Action was taken to recommend adoption as standard of the Tentative Methods of Test for Strength Properties of Prefabricated Architectural Acoustical Materials (C 367).

Whitewares and Related Materials

New Group on Nonmetallic Magnetic Materials Formed

Based upon the replies received from a questionnaire sent to a wide representation of those interested in ferrites, the newly organized ferrite section at its October meeting set up five working groups: A—Low-Frequency Material (High Power and Low Loss Ferrites); B—Television Material; C—Microwave Material; D—Computer Material (memory mechanisms); E—Permanent Magnets; F—Magnetic Powders (magnetic tapes and computer applications). The scope of the ferrite section will be limited to coverage of nonmetallic magnetic materials.

At the main meeting of Committee C-21 in Bedford Springs, Pa., on September 27, discussion centered on test methods useful to manufacturers of alumina whiteware, methods for measuring translucency, and definitions of whiteware tile products. A proposed method for determining the crazing resistance of fired glazed whiteware to autoclave treatment was reviewed for subcommittee ballot. Progress was indicated on pH, modulus of rupture, and particle-size analysis of whiteware clays, control testing of barium titanates, and their congeners.

The designation of Committee C-21 by the American Ceramic Society as its official group for promulgating ceramic standards (*Bulletin*, American Ceramic Society, Vol. 33, No. 8, p. 247 (1954)), and a growing interest in standardiza-

tion by the ceramic industry has prompted Committee C-21 to consider a reorganization based upon the establishment of a whiteware subcommittee. These points were reviewed to sound out the thinking of those present.

Porcelain Enamel

Spalling, Surface, and Subsurface Abrasion Tests Readied

DURING the meeting of Committee C-22 at Battelle Memorial Inst. on October 2 and 3, three test methods were proposed for committee action in June: the spalling test, surface abrasion, and subsurface abrasion.

The committee also reviewed the progress of a test for alkali and bleach resistance of porcelain enamel. The alkali resistance test apparatus has been purchased by several cooperating laboratories, and this work will be correlated with the field tests that have been completed by the National Bureau of Standards.

Five laboratories are currently collaborating on a coefficient of expansion test. Work on a torsion test of enameled sheet metal will be completed shortly. Projects in the early stages of work include the measurement of consistency of porcelain-enamel slips using a rotational viscosimeter; the enameling ability of iron or steel, and scratch resistance and metal marking of porcelain enamel.

A new program established for cast-iron enamelware will include tests for fusibility and workability, fit and toughness, enamelability of the cast iron, and adherence of the enamel to the metal.

A compilation of data for evaluation of the effects of porcelain enamels on low- and high-alloy steels at high temperatures has also been initiated.

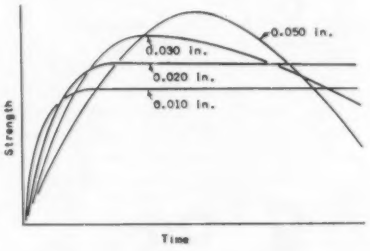
Adhesives

Method of Determining Gap-Filling Properties Presented

CRITICAL Glue Line Thickness at which the strength of the adhesive bond is not time-dependent, has been the subject of a research project at the University of Michigan. Since the establishment of this product, in 1952, special apparatus has been developed, a test program established, and a proposed method of determining gap-filling properties of wood adhesives presented to the committee at its October meeting in Washington, D. C.

The term "gap-filling" implies that an adhesive is capable of forming a strong bond where the adherends cannot make intimate contact. As a consequence, the term "critical glue line thickness" represents the maximum distance or gap between joint surfaces that a particular adhesive can tolerate.

The strength displayed by a joint under gap-filling conditions with most adhesives is time-dependent; that is, the strength observed depends upon the lapse of time between formation of the bond and its test. The dependence differs widely with thickness of the adhesive layer; hence the complete characterization of an adhesive for gap-filling properties should include behavior with respect to time. In a typical time-strength thickness curve illustrated below the ideal gap-filling adhesive should



theoretically not be time-dependent at any reasonable glue-line thickness, thus exhibiting a straight line parallel to the time ordinate.

Shear Strength

Since 1946 when the Section on Shear Strength proposed a method of determining the shear strength of metal-to-metal bonds, there has been much discussion concerning the rates of loading as specified in the Tentative Method of Test for Strength Properties of Adhesives in Shear by Tension Loading (Metal-to-Metal) (D 1002). Last year a program was established and interlaboratory collaborative work will begin this winter. The program will cover three adhesives having approximately 1000, 2500, and 4000 psi tensile strength; the two adherends are steel and 243 aluminum alloy with overlaps of $\frac{1}{2}$ and $\frac{3}{4}$ in. The four rates of loading are: (1) contant rate loading at 1200 to 1400 psi per min, (2) constant rate crosshead speed, (3) constant rate loading at 600 to 700 psi per min, and (4) constant rate loading at 2400 to 2800 psi per min.

Committee D-14 will recommend approval by the ASTM Standards Committee of the methods of testing the nonvolatile content of urea-formaldehyde adhesives; amylaceous material in adhesives; and nonvolatile content of aqueous adhesives. The methods presented for committee ballot are: measuring the hydrogen ion concentration of dry adhesive films; nonvolatile content of phenol, resorcinol, and melamine adhesives; filler content of adhesives.

The proposed specification for adhesives for acoustical materials, which is being produced in cooperation with Committee C-20 on Acoustical Materials, was presented for committee ballot.

Other specifications currently in subcommittee are for emulsion type adhesives for general purpose; polyvinyl, acetate, and resin emulsion type adhesives (alkali dispersible); adhesives for high-speed automatic machine labeling of glass bottles, and room-temperature and intermediate-temperature setting adhesives and high-temperature setting resin adhesives.

Electrical Insulating Materials

Corona and Arc-tracking Tests Show Progress

AN EERIE glow around a high-voltage insulator usually indicates the presence of a corona discharge. Some insulating materials will break down when subjected to corona, and others will maintain their insulating properties. Committee D-9 has for some time been working to develop test methods for measuring corona energy and for evaluating the corona resistance of insulating materials. So far, none of these methods has reached the point of a recommendation to the Society for publication as tentative, but at a meeting of the committee in St. Louis, October 17 to 19, it was decided that the work had progressed far enough to publish a method as information. This will appear in the next edition of the Compilation of Standards on Electrical Insulating Materials, scheduled for the spring of 1957.

Contamination on the surface of insulation can affect the resistance of the material to breakdown from arc tracking. In order to make available information on this problem to date, the committee recommended publication of a suggested method of test for dust and fog tracking. This method, to be published as information in the next insulating materials compilation, is intended for trial use only. Further development will be necessary before the method can be recommended to the Society as a tentative.

Silicones are assuming increasing importance as insulation for critical applications, and in keeping with the needs of the industry the committee has completed work on two new tentatives covering methods of testing silicone rubber-coated glass fabrics and tapes, and specifications for silicone varnished glass cloth and tape. These are being

recommended to the Society as tentatives. The committee has also recommended a fairly extensive revision of the Tentative Method of Test for Electrical Resistance of Insulating Materials (D 257). An interesting point in this revision is the use of the term "picofarad" which is synonymous with the well-known term "micromicrofarad."

Plastics

Aerodynamic Heating Problems Spark New Project

IT HAS been calculated that eggs can be brought to the boiling temperature by whirling them in air at a circumferential speed of Mach 1.3, that is, 1.3 × the speed of sound. While this is a rather impractical way to boil eggs it does illustrate a problem in the aircraft industry as speeds of planes exceed the speed of sound.

The ASTM Plastics Committee's Subcommittee XVIII on Reinforced Plastics met during the Los Angeles meeting in September and was attended by a number of people from the West Coast plastics companies, particularly those concerned with the application of reinforced plastics in aircraft. The interest was high and it was proposed that the interested group on the West Coast organize a section on high-temperature properties of plastics, to function as a part of ASTM Committee D-20. The organization of this group was approved by the committee at its meeting Oct 15–17, 1956, in St. Louis, and the group was formally organized under Subcommittee XVIII on Reinforced Plastics as Section G on High Temperature Resistance. While the nucleus of the organizing group is on the West Coast, membership in this section is not restricted to that area.

With increasing use of reinforced plastics in aircraft it is timely that the committee has organized to develop standard test methods to evaluate the properties of reinforced plastics over the range of temperatures they are likely to encounter.

For some time the electrical industry has been actively developing test methods to evaluate thermal capability of electrical insulation. K. N. Mathes at the Plastics Committee research session at St. Louis, reviewed the work on this problem in ASTM Committee D-9 on Electrical Insulating Materials. Since high-temperature resistance of reinforced plastics is a new project in the plastics committee, it was especially fitting that the thermal stability developments in the electrical insulating materials committee be reviewed. Other papers in the research session were as follows:

The Testing of Polyvinyl Chloride Electrical Formulations—G. W. Ashworth, J. R. Darby, W. E. Koerner, and R. H. Muncy, Monsanto Chemical Co.

A New Test Method for the Evaluation of Chemical Finishes on Glass Roving—P. W. Erickson and I. Silver, U. S. Naval Ordnance Laboratory

An Instrument for Measurement of Clarity of Polyethylene Film—R. J. Clark, H. C. Tucker, and R. F. Wall, Monsanto Chemical Co.

New Specification for Polytetrafluoroethylene

An item of completed business is the recommendation to the Society for publication as tentative of a new specification covering polytetrafluoroethylene, an important commercial material having exceptional thermal, electrical insulating, and chemical resistance properties. The committee has also recommended to the Society revisions of the test methods for tensile properties of plastics (D 638) and for tensile properties of thin plastic sheets and films (D 882).

The plastics committee approved a proposal from Committee D-9 on Electrical Insulating Materials to establish the former section on radiation effects on plastics as a joint subcommittee to consider the problems of radiation effects on plastics and electrical insulation. Organization of the joint subcommittee is reported elsewhere in this issue.

The many other active projects in the Plastics Committee include revision of the polyethylene specification D 1248, development of standards for plastic pipe and for cellular plastics.

Materials for Electron Tubes, Semiconductors

Series String Tubes Challenge Committee

WHEN the heaters of electron tubes are connected in series, as they are in many pieces of electronic equipment, all carry the same current. If the voltage drop across each tube is not the same or very nearly so, the cathodes do not reach the same temperature and a variation in emission results. The properties of the fine wire used in these heaters must be controlled to more narrow tolerances when tubes are connected in series than when they are connected in parallel. Tolerances for fine wire was one of many problems considered by Committee F-1 at its meeting on October 4 and 5 in Cleveland, Ohio.

Special problems are encountered in electron tubes in the sealing of metals to nonmetals as in the bringing out of electrode leads through the tube envelopes. The lead material, an alloy called lumet, must first be coated with an oxide layer to provide a compatible seal with the nonmetal. The thickness and uniformity of this oxide layer can be observed microscopically by cross-sectioning the lead wire, or an indication of its quality may be obtained from visual observation of the color. The committee is currently concerned with setting up methods for evaluating this coating on the lead wire, so that correlations may be obtained between the quality of the coating as determined by a standardized method and the quality of the seal between the metal and the nonmetal.

The group concerned with semiconductors has made very good progress in reaching preliminary agreement on methods of testing germanium oxide and germanium metal in the form of a bar or ingot. The group is now ready to tackle similar problems on silicon, also an important industrial semiconductor metal. It is anticipated that the problems on silicon will be more difficult than those on germanium, and for this reason the germanium problems had been tackled first.

Work on luminescent materials is progressing to the point where drafts for committee ballot of methods for wet adhesion and particle size may soon be completed. The group is continuing its work toward development of a demountable tube for studying luminescent materials.

UHF Dielectric Properties

The group concerned with insulators, at the request of several ceramics producers, will establish a task group to develop methods of test for dielectric properties of ceramic insulators for use at high temperatures and at frequencies in the range of 1 to 30 kilomegacycles. The group will consist of several producers of ceramics and several power tube manufacturers who used these materials in klystrons, traveling wave tubes, and the like. The insulator group is also endeavoring to develop a method for evaluating mica from different sources for use in electron tubes. While several interlaboratory tests have been carried out, the data obtained so far do not indicate a satisfactory means for differentiating these micas. Both mechanical and electrical characteristics have been found to be important.

Is There Need for a Standard Triode?

Several years ago the committee developed a standard diode for evaluating

thermionic emissive properties of materials (F 270). This method was first published as information in 1951 and was accepted as tentative at the Annual Meeting of 1952. While the standard diode does provide considerable useful information especially in connection with emissive properties, it provides no information about sublimation characteristics of cathode materials, grid emission, or gassiness. For some time the committee has been considering development of a standard triode and a number of suggestions have been made. To the uninitiated, it might seem that an ordinary production triode like the 6C4 could be adapted as a standard triode for evaluating tube materials. In the opinion of the committee, however, a standard triode would have to be very special both in design and in the materials used, and this is not feasible in a tube which is manufactured by high-speed techniques. The committee is spurring its efforts toward reaching an agreement on first the geometry and later the materials and construction requirements for a standard triode which will be useful in testing all tube materials and not just cathodes, as in the standard diode. A. P. Haase of General Electric Co. was appointed chairman of a task group to develop a standard triode.

Because of common interests with other ASTM committees, Committee F-1 appointed representatives on Committee E-2 on Emission Spectroscopy; Committee E-3 on Chemical Analysis of Metals; and Committee D-9 on Electrical Insulating Materials, Subcommittees on Mica, Ceramics, and Electrical Tests.

Leather

Tough Material—Tough Problems

PROBABLY no other material of natural origin is subject to more inherent variability than leather. Physical properties vary more widely from one place to another on a given hide than in the same spot from hide to hide. The problem of sampling leather for physical testing is thus a difficult one, and in order for test results to be meaningful, the sampling procedures must be very carefully specified. These and other problems occupied the attention of the ALCA-ASTM Joint Committee on Leather at its meeting on October 22, in New York.

C. W. Mann, chairman of the Subcommittee on Sampling and Conditions for Physical Testing, outlined the plans for this group to develop sampling procedures. He pointed out that while considerable data are available on sampling of side upper leather it will be necessary to extend this information to cover welting leather, for example, and for sampling other types of leather such as calfskins and sole leather. The present sampling techniques for side leather described in methods of the American Leather Chemists' Assn. and the Federal Government will serve as a guide to extend this work to other leathers.

The Subcommittee on Nomenclature and Definitions, Robert M. Lollar, chairman, will prepare a dictionary of leather terms, using as a general source of definitions Section 5 of Federal Specification KK-L-311a. The need for definitions is illustrated by the unit used for measuring thickness of leather, the "iron," which has a value of $\frac{1}{48}$ in. There are many terms long used in the leather industry which will need to be defined for use with test methods to be developed by the committee.

The Subcommittee on Research, M. M. Baldwin, chairman, is compiling a list of research projects on test methods currently in progress in members' laboratories and in the industry generally. The research committee will also recommend areas for research on new test methods and will arrange for technical papers sessions at future meetings of the Joint Committee.

The committee is also actively developing a number of physical test methods for leather, including tests for tensile properties, surface characteristics, deterioration, effect of water, and fire resistance.

Mass Spectrometry Committee Sponsors Conference in New York

THE FIFTH Conference on Mass Spectrometry, under the sponsorship of ASTM Committee E-14, will be held at the Commodore Hotel in New York City the week of May 20, 1957.

Papers are welcome on all phases of mass spectrometry. A special effort is being made to arrange several symposiums of theoretical and analytical interest. A symposium on negative ions will definitely be held. Abstracts of papers should be submitted by February 15, 1957, to a co-chairman of the Subcommittee on Programs and Papers:

R. A. Friedel or
A. G. Sharkey, Jr.
U. S. Bureau of Mines
4800 Forbes St.
Pittsburgh 14, Pa.

Partridge and Herzig—1957 Lecturers

EVERETT P. PARTRIDGE, director of Hall Laboratories Inc., and Alvin J. Herzig, president of Climax Molybdenum Co. of Michigan, have been selected to deliver the 1957 Marburg and Gillett Lectures, respectively.

The Marburg Lecture by Mr. Partridge will be on the subject of water. Mr. Herzig's Gillett Lecture will deal with molybdenum and columbium.

ASTM Organizes for Radiation Studies on Plastics and Insulation

THE formation of a subcommittee to study the effects of nuclear and high-energy radiation on the properties of plastics and electrical insulation was approved as a joint activity of two ASTM committees. Chairman of the new subcommittee is D. S. Ballantine of Brookhaven National Laboratory. At the first meeting of the group in St. Louis, on Oct. 16, 1956, the chairman emphasized the great need for standardization in the field of radiation effects and the timeliness of ASTM's decision to form such a committee. The data already existing in the field of radiation effects on materials are in many cases confusing, and instances of outright contradictions are not uncommon. This condition prevails in part because (1) different sources of radiation are employed, (2) different methods are used to determine and express the radiation doses which have been received, (3) the irradiations are done under differing conditions of atmosphere, temperature and time, and (4) because different test methods are used to evaluate the results.

It is the prime objective of this new subcommittee to establish where possible, standard methods of irradiation and standard methods for determining the effects of radiation on the physical and chemical properties of plastics and electrical insulation. The subcommittee on radiation effects sponsored jointly by ASTM Committees D-20 on Plastics and D-9 on Electrical Insulating Materials has established sections to work in the following areas: (*a*) nomenclature and definitions, (*b*) dosimetry, (*c*) correlation of various sources of radiation, (*d*) total dosage and dose-rate effects, and (*e*) post irradiation effects.

Anyone interested in the work of this committee is invited to write to the chairman, D. S. Ballantine at Brookhaven National Laboratory, Upton, N. Y.

Proposed Tentative Method of Test for Environmental Stress Cracking of Ethylene Plastics*

(Published as Information Only)

THE PHENOMENON of environmental stress cracking of ethylene plastics has received considerable attention in recent years. Subcommittee XV on Thermoplastic Materials of ASTM Committee D-20 on Plastics established a task group in November, 1954, within its Section J on Ethylene Plastics to investigate this phenomenon for possible inclusion as a limiting parameter of ASTM Specification for Polyethylene Molding and Extrusion Materials (D 1248).[1] Much progress toward a test method has been accomplished by this group but two large round-robin test programs have demonstrated considerable variation in the results obtained in different laboratories. Data from interlaboratory tests are shown in Tables I and II. Within a given laboratory successive test runs generally give good agreement while better correlation between laboratories is obtained when specimens are prepared at one central laboratory than when each laboratory prepares its own. Another cooperative test program is now planned to uncover the factors affecting these large discrepancies between laboratories and a means of rigidly controlling them.

Industry-wide interest in this test is now very high but the difficulties in reproducibility between laboratories are not well appreciated. The task group feels the method may now only be useful as a routine inspection and acceptance test by individual laboratories without expectation of agreement between laboratories. For this reason the method is so presented here for publication as information only.

Scope

1. (*a*) This is a method of test for determining the susceptibility of ethylene plastics to environmental stress cracking when subjected to the conditions herein specified. Under certain conditions of stress and in the presence of environments such as soaps, wetting agents, oils, and detergents, ethylene plastics may exhibit mechanical failure by cracking.

(*b*) The method consists of exposing bent specimens of the plastic having a controlled imperfection on one surface to the action of a surface-active agent.

Significance

2. (*a*) This method may be used for routine inspection purposes by subjecting a required number of specimens to the test conditions for a specified time and noting the number that fail. The cracking obtained with the test reagent is indicative of what may be expected from a wide variety of surface-active agents, soaps, and organic substances which are not absorbed appreciably by the polymer.

(*b*) Stress cracking is a property that is highly dependent on the nature and level of the stresses applied. Under the conditions of the test, high local multiaxial stresses are developed through the introduction of a controlled imperfection. Stress cracking has been found to occur most readily under such conditions. Because of this dependence upon level of applied stress this test may only be applicable to ethylene plastics of similar modulus. Comparisons between samples of widely different modulus may not be significant.

(*c*) Where stress concentrations are low, as in thin-wall sections, cracking may not occur even in the presence of a cracking agent. Information from this test is not intended for direct application to engineering problems but should be considered primarily as a classification test for ethylene plastics.

Definitions

3. (*a*) *Stress Crack.*—External or internal cracks in a plastic caused by tensile stresses less than that of its short time mechanical strength.

NOTE.—The development of such cracks is frequently accelerated by the environment to which the plastic is exposed. The stresses which cause cracking may be present internally or externally or may be a combination of these stresses. The appearance of a network of fine cracks is called crazing.

(*b*) *Stress Crack Failure.*—For purposes of this test, any crack visible to the unaided eye shall be interpreted as a failure. Extension of the controlled imperfection shall not be construed as a failure.

NOTE.—Cracks generally develop at the controlled imperfection and run to the outer edge of the specimen approximately at right angles to it. The cracks need not extend completely through the specimen to constitute failure.

Apparatus

4. (*a*) *Blanking Die.*—A suitable rectangular die for cutting specimens 1.5 ± 0.1 in. by 0.50 ± 0.03 in.

(*b*) *Jig.*—A jig for making a controlled imperfection 0.750 ± 0.005 in. long and 0.020 to 0.025 in. deep, parallel to the long edges of the specimen and centered on one of the broad faces. The jig shown in Fig. 1 shall be used.

NOTE.—Drawings of this jig may be obtained from ASTM Headquarters.

(*c*) *Specimen Holders.*—Lengths of hard brass channel having the dimensions shown in *B* of Fig. 2 shall be used. Any burrs present on the inside of the channel should be removed.

(*d*) *Rectangular Brass Guide Bar.*—½ by $\frac{3}{16}$ by 8-in. bars.

(*e*) *Test Tubes.*—Pyrex glass tubes nominally 200 mm long with an outside diameter of 32 mm.

(*f*) *Corks.*—No. 15.

(*g*) *Aluminum Foil.*—Approximately 0.005 in. thick in which to wrap the corks.

(*h*) *Constant Temperature Bath.*—A constant temperature liquid bath maintained at 50.0 ± 0.5 C.

(*i*) *Test Tube Rack.*—A rack to hold test tubes immersed to reagent level.

Reagent

5. (*a*) Igepal CO-630 obtained from General Dyestuff Corp., New York, N. Y.

NOTE.—This is an alkyl aryl polyethylene glycol. The reagent should be stored in closed metal or glass containers because it is somewhat hygroscopic.

(*b*) Fresh reagent shall be used for each determination.

Specimen Preparation

6. (*a*) Specimens shall be die cut from smooth pressed sheet to the dimensions given in Fig. 2*A* and the die shall be such that clear cuts are made. The sheet may be pressed from granules or pellets, or from plaques of milled material.

TABLE I.—ENVIRONMENTAL STRESS CRACKING OF POLYETHYLENE WITH SAMPLES PREPARED AT CENTRAL LABORATORY.[a]

Hours for 50 per cent Failure

Laboratory	Run No. 1	Run No. 2	Average
A	4.0	2.5	3.3[b]
B	8.2	6.5	7.3
C	2.0	24.0	13.0
D	8.3	6.0	7.2
E	10.0	16.0	13.0
F	13.0	24.0	18.5[b]
		Average	10.4

TABLE II.—ENVIRONMENTAL STRESS CRACKING OF POLYETHYLENE WITH SAMPLES PREPARED AT INDIVIDUAL LABORATORIES.[a]

Hours for 50 per cent Failure

Laboratory	Run No. 1	Run No. 2	Average
G	100	200	150
H	>336	>336	>336
I	12.0	4.9	8.0
J	24.0	27.0	26.0
K	5.8	2.3	4.0
L	10.0	10.0	10.0
		Average	?

[a] Data from second round robin. Polyethylene of same batch and manufacturer in both tables. Each run consisted of ten samples.

[b] Known deviations in test procedure inadvertently occurred.

* Reprints available from Headquarters—30 cents.

[1] Tentative Specifications for Polyethylene Molding and Extrusion Materials (D 1248 – 52 T), 1955 Book of ASTM Standards, Part 6, p. 109.

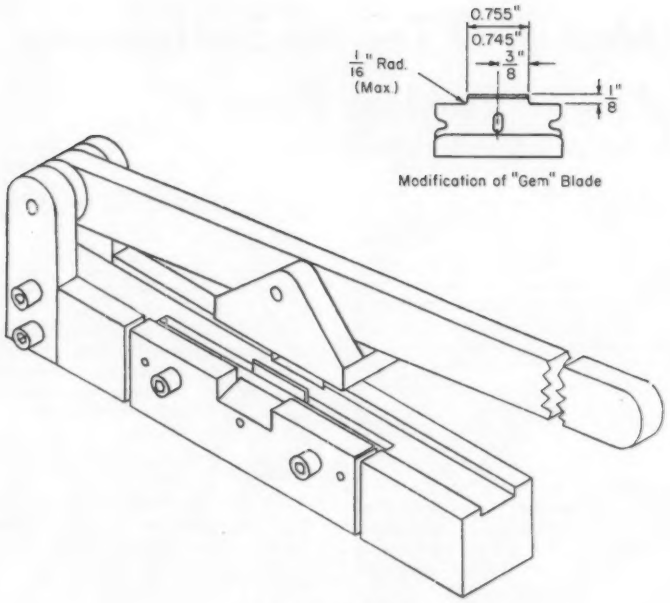


Fig. 1—Nicking Jig.

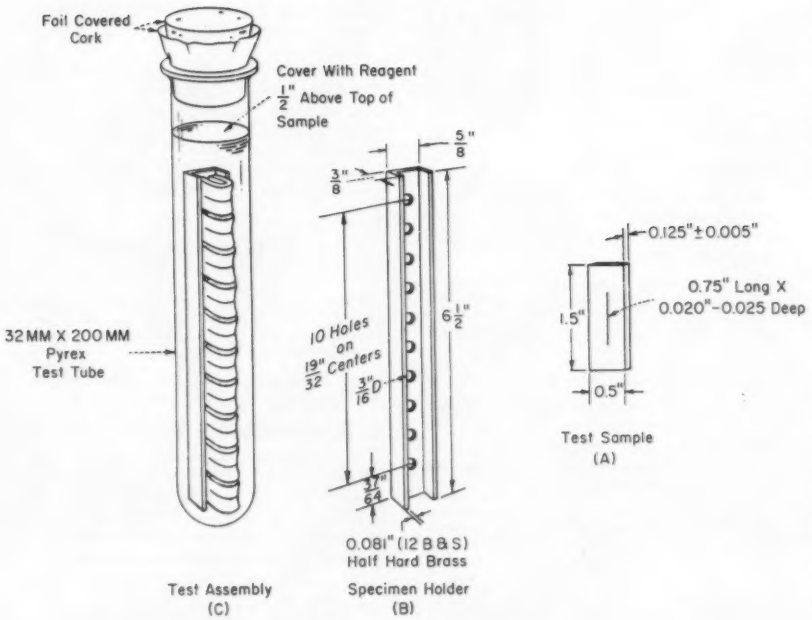


Fig. 2—Test Equipment.

NOTE.—Where a sample is homogenized by milling, it shall be preformed for no longer than 10 min at the lowest temperature possible for each resin.

(*b*) A molding procedure shall be used that will assure dense uniform sheets with low internal stresses. Sheets may be examined for internal stresses by taking specimens from random locations on the sheet and placing them in a petri dish containing $\frac{1}{8}$ in. of talc and setting the dish in an air oven at 130 C for 30 min. If shrinkage of the specimens is less than 10 per cent in the lengthwise direction, the molded sheet can be considered satisfactory.

Conditioning

7. The specimens shall be submerged in boiling water for 30 min and shall then be equilibrated to 23 ± 1.1 C (73.4 ± 2 F) as defined in ASTM Methods D 618.[2] Stress cracking tests shall be started within 24 hr after the boiling water annealing has been completed. The test specimens shall not be bent and shall not be treated with the reagent until immediately prior to the test.

Procedure

8. (*a*) Each specimen shall be given a controlled imperfection on one surface as shown in *A* of Fig. 2. A sharp blade mounted in the jig shown in Fig. 1 shall be used for making this imperfection. The blade should be replaced whenever there is any question of its having become dull or damaged. In no case should it be used for more than 1000 specimens.

(*b*) The rectangular brass bar is placed lengthwise in a channel with the $\frac{3}{16}$ in. wide side resting on the bottom. The bar may be centered in the channel by placing an unbent specimen on either side as a spacer. A test specimen is bent, with the controlled imperfection on the outside, to form a loop until the inside tips are brought to rest against the sides of the guide bar extending above the channel. The specimen is then forced down until it rests on the bottom of the channel. When 10 specimens have been inserted the spacers are lifted out and the guide bar removed by sliding it through the bent specimens.

(*c*) Within 10 min of the time the first specimen is introduced into the holder, the holder shall be inserted in the test tube. The tube is then filled to approximately 0.5 in. above the top specimen with reagent that has been adjusted to a temperature of 23 ± 1.1 C. The tube is then stoppered with a foil-wrapped cork and immediately placed in the constant temperature bath at 50.0 ± 0.5 C. The controlled imperfections should not be touching the test tube during the test.

NOTE.—The heat capacity and the heat input capacity of the bath should be high enough so that the temperature does not drop below 49.5 C when the samples are added.

Routine Inspection and Acceptance

9. For routine inspection of materials it shall be satisfactory to accept lots on the basis of testing 10 specimens for a specified time. Not more than 5 shall fail.

Report

10. The report shall include the following:

(*1*) Per cent failed specimens at specified time.

(*2*) Complete identification of material tested.

(*3*) Date of test.

(*4*) Name of observer.

References

(1) R. H. Carey, "Stress Cracking of Polyethylene," ASTM BULLETIN, No. 167, p. 56, (July, 1950).

(2) J. C. DeCoste, F. S. Malm, V. T. Wallder, *Industrial and Engineering Chemistry*, Vol. 43, p. 117 (1951).

(3) I. L. Hopkins, W. O. Baker, J. B. Howard, *Journal of Applied Physics*, Vol. 21, No. 3, pp. 206–213, (March, 1950).

[2] Methods of Conditioning Plastics and Electrical Insulating Materials for Testing (D 618 – 54), 1956 Book of ASTM Standards, Part 6, p. 447.

Proposed Method of Test for Calcium and Magnesium Oxides in Lime

EDITOR'S NOTE.— Committee C-7 on Lime has been interested in the development of a rapid method for determining calcium and magnesium oxides in lime to be used for routine control analysis. Subcommittee V on Methods of Test of Lime and Lime Products, D. G. Hamme, Chairman, has submitted this method to be published as information only. It is hoped by this publication that broader use of the method may be accomplished and comments secured for further consideration of the subcommittee.

Scope

1. This method covers a volumetric procedure for routine control analysis for calcium and magnesium oxides in lime, limestone, or dolomite.

Principle of Method

2. The method is based on the principle that, at pH 10, the wine-red colored magnesium chelate of the dye, Chrome Black T, color index 203, is less stable than the magnesium chelate of sodium ethylenediamine tetraacetate. Thus, the dye color, originally wine-red in the presence of magnesium ion, suddenly changes to blue at the end point when the chelation of magnesium with sodium ethylenediamine tetraacetate is complete.

Interfering Elements

3. (*a*) Barium and strontium in moderate amounts do not affect the titration results for calcium. However, in the titration for total hardness both barium and strontium titrate before magnesium and therefore results for magnesium oxide (MgO) will be high by an amount equivalent to the barium and strontium present. The addition of 3 to 4 ml of saturated potassium sulfate solution before titrating for magnesium appears to practically eliminate the interference of barium and strontium.

(*b*) Copper and manganese in excess of 10 ppm interfere but are not normally present in sufficient quantity to affect results.

(*c*) Samples that are high in iron and aluminum oxides (R_2O_3) or magnesium, or both, form precipitates of hydroxides at the pH necessary for the complete chelation of calcium ions. Precipitating R_2O_3 by adjusting the pH to 5 to 6 and allowing the precipitate to settle before removing aliquot for titration has not been beneficial. In the case of magnesium, the precipitate dissolves as the end point is reached. With high R_2O_3 content the precipitate does not dissolve, but with continued stirring it becomes finely dispersed and does not interfere with the end point to any appreciable extent.

Interfering Minerals

4. Samples containing mica yield low results for magnesium oxide (MgO) when treated as Section 7. Excellent results are obtained by filtering the hydrochloric acid solution of the sample, fusing the residue with 1 g of anhydrous sodium carbonate, and dissolving the fusion in the acid filtrate before diluting to volume in the 1-liter volumetric flask. Make carbonate fusions with all samples from unknown sources by the fusion method if they carry an excessive amount of silica (SiO_2) plus other insoluble materials.

Purity of Reagents

5. (*a*) Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.[1] Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

(*b*) Unless otherwise indicated, reference to water shall be understood to mean distilled water.

Reagents

6. (*a*) *Calcium Chloride, Standard Solution (1 ml. ≡ 0.00028 g CaO).*—Dry $CaCO_3$ for 2 hr at 110 C in a weighing bottle. Stopper and cool in a desiccator. Transfer a 0.5000-g portion to a 250-ml beaker, wet with water, cover, and slowly add 3 ml of HCl. Boil a few minutes, cool, and transfer to a 1-liter volumetric flask. Dilute to 1 liter and mix thoroughly.

(*b*) *Calcium Indicator Solution.*—Grind together 0.2000 g of ammonium purpurate and 40 g of sodium chloride (NaCl) with a mortar and pestle.

(*c*) *Hardness Buffer Solution.*—Weigh 33 g of ammonium chloride (NH_4Cl) into a 400-ml beaker and dissolve in approximately 150 ml of water. Transfer to a 500-ml volumetric flask and add 280 ml of NH_4OH (sp gr 0.90). Dilute to the mark with cold water and mix.

(*d*) *Hardness Indicator Solution.*—Dissolve 0.5 g of Chrome Black T, color index 203[2] (1-(1-hydroxy-2-naphthylazo)-5-nitro-2-naphthol-4-sulfonic acid sodium salt) and 4.5 g of hydroxylamine hydrochloride in 100 ml of alcohol. Store in a glass-stoppered bottle. This solution is stable for at least two months.

(*e*) *Hydrochloric Acid (sp gr 1.19).*—Concentrated hydrochloric acid (HCl).

(*f*) *Magnesium Chloride Solution (2 g per liter).*—Dissolve 2.0 g of MgCl in water. Add 2 ml of HCl and dilute to 1 liter.

(*g*) *Potassium Hydroxide Solution (200 g per liter).*—Dissolve 40 g of HOH pellets in water and dilute to 200 ml.

(*h*) *Sodium Ethylenediamine Tetraacetate, Standard Solution (1 ml = 0.00000 g MgO.*—Dissolve 3.7500 g of disodium ethylenediamine tetraacetate dihydrate in 400 to 500 ml of water containing 0.5 g of sodium hydroxide (NaOH). Transfer to a 1-liter volumetric flask and dilute to 1 liter. Standardize as follows: Measure 25.00 ml of calcium chloride ($CaCl_2$) solution (1 ml = 0.0005 g) from a buret into a 210-ml casserole at a rate not to exceed 10 ml per min. Add 10 ml of water, 1 ml of KOH solution and 150 ml of calcium indicator solution, and continue as directed in Section 7(*c*). (Note 1.)

Titrate three 25-ml aliquots and take the average value of the three titrations, which should not vary by more than 0.02 ml. The disodium ethylenediamine tetraacetate solution should be protected from air and restandardized against the standard $CaCl_2$ solution at least once a month. Calculate the magnesia (MgO) equivalent as follows:

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] "Reagent Chemicals, American Chemical Society Specifications," Am. Chem. Soc., Washington, D. C. For suggestions on the testing of reagents not listed by the American Chemical Society, see "Reagent Chemicals and Standards," by Joseph Rosin, D. Van Nostrand Co., Inc., New York, N. Y., and the "United States Pharmacopoeia."

[2] Eriochrome Black T, manufactured by Geigy Co., Inc., New York, N. Y.; Omega Chrome Black S, manufactured by Sandoz Chemical Works, Inc., New York, N. Y.; Pontachrome Black TA, manufactured by E. I. du Pont de Nemours & Co., Wilmington, Del.; and Eriochrome Black T, Catalogue No. P6361, Eastman Kodak Co., Rochester, N. Y., are satisfactory for this purpose.

$$\text{CaO equivalent} = (A/B) \times 100$$

$$\text{MgO equivalent} = 0.7191 \times \text{CaO equivalent}$$

where:

A = CaO equivalent of 25.00 ml of the standard $CaCl_2$ solution, and

B = milliliters of sodium ethylenediamine tetraacetate solution required for titration of the $CaCl_2$ solution.

NOTE 1.—The titration of the standard $CaCl_2$ solution with the standard ethylenediamine tetraacetate solution for total hardness should yield the same values as those obtained in the CaO titration. To check this, measure 25 ml of water into a clean casserole, add 2 ml of hardness buffer solution and 5 to 6 ml of the $MgCl_2$ solution. Now add 3 to 4 drops of hardness indicator solution and titrate with standard ethylenediamine tetraacetate to change from wine-red to a pure blue end point. Add the ethylenediamine tetraacetate slowly and allow a few moments time between each drop when nearing the end point. "Split" a drop if necessary to avoid overreaching the end point. Now measure exactly 25 ml of the standard $CaCl_2$ solution into the contents of the casserole and titrate again to the blue end point as outlined above. Another drop or two of indicator may be added just before the end point is reached, if the color of the solution has faded. The volume of ethylenediamine tetraacetate solution required for the last titration should be the same as that required for the CaO titration; if not, check the water and all reagents for magnesium and determine a blank correction factor.

Procedure

7. (*a*) Weigh 0.5000 g of the sample into a 250-ml beaker and wet with 10 ml of water. Cover with a watch glass and slowly add 5 ml of HCl. Keep covered and boil down to 3 to 4 ml volume to decompose the sample and to expel excess acid. Dilute with water to 50 to 60 ml and boil 5 min longer. Cool and transfer to a 1-liter volumetric flask. Dilute to the mark with cool water and mix thoroughly.

(*b*) Drain the buret used for standardizing the standard $CaCl_2$ solution and rinse twice by filling with the sample solution and draining. Refill the buret with the sample solution.

(*c*) *Titration for Calcium.*—Measure 25.00 ml of the sample solution into a casserole. Add 10 ml of water, 1 ml of KOH solution, and 150 ml of calcium indicator solution. Stir and titrate with standard sodium ethylenediamine tetraacetate solution. Add the solution only 1 drop at a time as the color starts to change from pink to orchid, stirring after each addition and noting color change. Read the buret to the nearest 0.01 ml between each addition; when the final drop shows no further change in color, consider the end point as being the previous reading (Note 2).

NOTE 2.—If in doubt about the end point, check until two results are obtained that agree within 0.02 ml and take the average.

(*d*) *Titration for Calcium Plus Magnesium* ("*Total Hardness*").—Measure from the buret (Paragraph (*b*)) 25.00 ml of the sample solution into a casserole. Add 25 ml of water and 2 ml of hardness buffer solution. Titrate with standard sodium ethylenediamine tetraacetate solution until within 0.1 to 0.2 ml of the volume expected to be required to reach the end point (Note 3). Add 1 to 2 drops of hardness indicator solution, which should produce a wine-red color in the solution. Continue the titration until the last drop changes the color to pure blue.

NOTE 3.—For this titration it is desirable to add the indicator just prior to reaching the end point. This can be accomplished by titrating one 25.00-ml aliquot to which the indicator has been added in order to establish the approximate end point before the titration for the exact end point is made.

Calculations

8. Calculate the percentages of CaO and MgO as follows:

$$A = C \times D$$

$$B = (E - C)\, D \times 0.7191$$

where:

C = milliliters of standard sodium ethylenediamine tetraacetate solution added in titrating for calcium,

D = CaO equivalent of the ethylenediamine tetraacetate solution, and

E = milliliters of standard sodium ethylenediamine tetraacetate solution added in titrating for calcium plus magnesium.

The Conservation of Nickel in a Free Economy

Editor's NOTE.—On November 5 Secretary of Defense Charles E. Wilson signed a statement addressed to American industry that will be of interest to many readers of the ASTM BULLETIN.

"MANY segments of industry are learning to do without nickel, to make better use of nickel scrap, and to use alloys containing less of this valuable metal. The current shortage of nickel makes this a wise course; the Office of Defense Mobilization has announced that nearly eighty million pou of nickel were diverted from the National Stockpile to ease the shortage in 1956 and that no nickel at all will go into the stockpile during the first quarter of 1957.

"The steel industry has made a strong effort to ease the current nickel shortage by stimulating a shift to a new stainless-steel alloy using manganese to replace about half the nickel. This one substitution alone, if energetically pressed, would reduce by as much as 10 per cent the national consumption of nickel. Stated another way, it would enable the nickel available to us to do just that much more work. The American Iron and Steel Institute has recognized the acceptability of this new stainless steel and has assigned it the number '200' to distinguish it from the nickel-rich '300' series of stainless steels.

"About one-third of all nickel goes to direct military and atomic energy uses. All three military departments have told their designers to seek out ways to replace high-nickel stainless steels in their equipment with the new manganese-type alloys, or with nickel-free stainless steels, or with aluminum, or plastics, or other non-nickel materials. National policy requires that military needs for nickel be met in full. However, fullest use of the substitute materials throughout all industry would also enable stockpiling to proceed and leave a more abundant remainder for civilian consumption.

"I appeal to private industry to cooperate with the Department of Defense by looking for places to save nickel in equipment outside military design control. If you in industry are resourceful in conserving nickel while producing soundly engineered products acceptable to the public it will prove that in this country we can take practical measures to use materials more effectively, without dictation or regulation.

"We will not in future years be able to afford the lush expenditures of minerals we are making today. As we grow wise, skillful, and prudent in our use of these materials it will help us to meet the challenge of future growth and still live within our national resources of minerals."

Random Samples...

FROM THE CURRENT MATERIALS NEWS

From the broad stream of current materials information flowing from "in-box" to "out-box" in a busy editorial office, random samples (mostly random) have been plucked. Thinking them worth re-showing to ASTM'ers who may have missed the original articles, we have included them here. Of course, we had to trim the samples to fit. There will be those who are not satisfied with samples, especially ones which are not really random. But these ASTM'ers can contact the institution, magazine, governmental agency, etc., who placed the original information in the stream, or address Random Samples, ASTM, 1916 Race St., Philadelphia 3, Pa.

Ceramics Without Firing

With a new cement it is now claimed to be possible to make ceramic-like products for technical and industrial use by a cold-set process without kiln firing. Special shapes may be cast in molds of linoleum, cardboard, wood, rubber, or metal where the quantity does not justify machine molds.

The Sauereisen Cements Co., Pittsburgh, Pa., has announced the development of a synthetic porcelain ceramic to be known as Sauereisen Pour-Lay Cement No. 54.

Sauereisen No. 54 is supplied in two parts, a dry filler and a liquid binder, which are mixed together as it is used. Nothing else is added. Mixing may be done either by hand or with a mixer. The cement hardens with an internal chemical setting action with an initial set in approximately 30 min and a final complete set in 6 to 12 hr at ordinary temperatures.

The synthetic ceramics are claimed to have many advantages over fired ceramics, in addition to some features not duplicated. For instance, if nonporosity is desired, the No. 54 Cement may be impregnated with various materials such as varnish, wax, etc. Sauereisen No. 54 will resist water, oil, electricity, solvents, all acids (except hydrofluoric), and temperatures to 2000 F. Mechanical strength is about the same as concrete. Cost-wise the cement will run within the same range as an electrical porcelain or tile body. The No. 54 offers a considerable saving in time by eliminating long drying and kiln firing.

Ashes to Ashes and Dust to Dust

Atomic energy has now passed what looked to be insurmountable hurdles 15 short years ago. However the future of this new source of power is clouded by one obstacle that can have a far-reaching influence on its progress and widespread use. This impediment is the waste elements produced by reactors in nuclear-fueled power plants. There is immediate need for a practical way to keep atomic energy from burying itself in its own wastes.

Unlike ashes from a furnace which can be used as fill, for construction purposes, or cindering icy roads, the wastes from a nuclear reactor must be discarded away from contact with humans or with anything that may in the far future be used or handled by humans or animals.

Fortunately, the indifferent attitude which prevailed for years toward the contamination load placed upon our streams by the dumping of municipal and industrial wastes will not apply in this case. An intensive research project at the Brookhaven National Laboratory has resulted in a theoretical answer. The engineering and incorporation of this theory into practical working processes and machinery has been turned over to the Atomic Energy Department of Blaw-Knox Company's Chemical Plants Division.

Nuclear reactors produce a waste that is dangerously radioactive, and nothing can be done to destroy the radioactivity or shorten its life in any way. The only answer is to put it safely away, not for months or years, but for centuries. Some elements in the waste have radiation lives, and will be dangerous, as long as 600 years. Furthermore, this radiation generates heat, which must be carried away, otherwise, terrific temperatures will result. The practice thus far has been to store it in water and carry the heat away through cooling coils, using water or refrigeration equipment. Rather than being simple water tanks, these containers are part of complicated systems costing from $1 to $7 per gallon capacity.

Already there are millions of gallons of aqueous solutions of these wastes stored in these costly underground tanks at the various atomic energy plants. And more would have to be built for every new atomic energy plant constructed, if a new method had not been conceived for disposing of the wastes. It is estimated that for every 1000 to 2000 megawatts of electrical power generated, sufficient for a city the size of Pittsburgh or Philadelphia, a new one-million gallon waste storage tank would have to be installed every year, at a cost of up to $7 million. Of course, after 600 years each plant would have enough tanks, at a total investment of about $4200 million, to start rotating use, but where could space be obtained to put this number of tanks in each community?

Brookhaven National Laboratory was given the job of finding an answer, and now the responsibility has been passed on to Blaw-Knox to put the idea into workable processes and machines. The end result involves engineering a plant that will concentrate the waste in solid form, so that liquids will not leach out the radioactivity and contaminate surrounding areas. Once prepared in these sintered powders, research may be continued into the feasibility of securing the material in suitable containers for storage on land or sea. If the ocean were used for disposal, it is expected that the vast amount of water and natural currents would furnish the necessary cooling, but scientists are facing reality when they insist that more information must be obtained on conditions prevailing deep under the ocean surface, and how they will affect this storage.

The process planned for the concentration of this nuclear waste lends itself to the separation of elements having different radioactive lives which will offset some of the operating costs by providing isotopes for many industrial, medical research, and food irradiation uses. Even with this distribution of isotopes, the eventual problem of final disposal still remains because of their dangerous characteristics.

That Temperature Barrier

The penetration of a critical temperature barrier in the development of guided missiles and supersonic aircraft was dramatically demonstrated recently when General Electric scientists exhibited laboratory models of revolutionary electronic devices and circuits operating literally "red hot." The achievement was described as a major

step toward overcoming the inability of electronic controls to withstand the skin-sizzling heat generated by air friction at extreme speeds.

Inside glowing electric furnaces and surrounded by blazing blow-torches, General Electric's new vacuum tubes, capacitors, resistors, transformers, inductors, wires, printed circuit boards, and even an electric motor, were operated at temperatures ranging from 900 to 1500 F. The performance of the components compares favorably with previous devices that would operate only at low temperatures. Metals such as titanium and special laboratory-designed ceramics play important roles in the design and construction of high-temperature components.

An equally important feature of the new electronic circuits is their ability to operate for long periods while exposed to intense nuclear radiation in an atomic reactor. Electronic assemblies have been operated at high temperature for more than 1000 hr in the neutron flux of the graphite reactor at the Oak Ridge National Laboratory.

It was also emphasized during the demonstrations that high-temperature electronic components can have important applications in industry as well as in defense. The new metal and ceramic components show unusual adaptability to manufacture by automation. Another advantage of these new concepts of electronic design is the possibility of building basic, interchangeable electronic units that include several components—tubes, resistors, capacitors, and many other items.

It was made clear that the devices shown are laboratory models, completely workable but not in production at this time and not available for sale. Much of the basic scientific research behind the announcement has been in the area of new materials—metals, alloys, and ceramics. The need for high-temperature electronic components has encouraged the development of new materials that also will have important uses at room temperatures.

Note for Automotive Engineers

Unburned fuel, 0.002 to 0.015 in. thick, around the walls of an automotive engine's combustion chamber, has been observed photographically by the General Motors research staff. Although it has been known that a small portion of fuel passes unburned through an engine, its source had never been established. Taken through a transparent quartz "window" in the engine, photos showed that when air-fuel mixture is ignited it flames across combustion chamber until almost touching the relatively cool chamber walls. Next to walls, the mixture does not burn. These findings may have significance in air pollution work.

Industrial Research Newsletter, Armour Research Foundation, October 1956

And Now the Fuel Cell Battery

The fuel cell, a battery that produces electricity from such gases as hydrogen and oxygen, is one of the many new devices under study at the new Parma, Ohio, Basic Research Laboratories of National Carbon Co., a Division of Union Carbide and Carbon Corp. When ultimately developed, commercial fuel cells may be used for reserve or standby power supplies.

In ordinary batteries, energy is obtained from metals and other substances in the form of charged particles. The flow of these particles is the electric current for flashlights, hearing aids, portable radios, and so on. Recent research indicates the new possibility of making a battery that will obtain its energy, its supply of charged particles, entirely from gases such as oxygen and hydrogen.

A possible version would include two basic unit sections. One section would consist of layers of porous carbon and a liquid-paste caustic solution with intervening space. Oxygen gas would stream into the space, and its molecules would move through the submicroscopic tunnels and channels in the porous carbon.

When the molecules reach the caustic layer they form a film, and reactions take place which produce negatively charged particles. This is the electron-consuming or "positive" section of the battery. The other section, the electron-supplying or "negative" unit, is constructed in a similar fashion. It makes use of a stream of hydrogen gas which reacts to produce positively charged particles.

Fuel cells will operate continuously, providing steady electrical currents as long as oxygen and hydrogen are fed into them. They have many potential applications. For example, they would furnish auxiliary power in chemical plants where these gases are by-products of commercial processes. Fuel cells could also be used as power supplies for light buoys and remote stations which are expected to run for several years without attention.

AWS Sessions on Welding in Nuclear Power Plants

WHERE and how welding is being used in the fabrication of nuclear power plants will be the subject of two technical sessions at the National Spring Meeting of the American Welding Society which will be held in conjunction with the Fifth Welding and Allied Industry Exposition in Philadelphia, April 8 to 12, 1957.

Several papers will discuss welding problems involved in designing and fabricating nuclear reactors and recently developed procedures and techniques for welding reactor components. Others will cover the effect of neutron radiation on weldability and mechanical properties of structural metals.

A special feature of this meeting will be the sponsoring of three sessions by the Committee on Electric Welding of the American Inst. of Electrical Engineers. Two sessions will deal with resistance welding; the third with arc welding.

In addition to the above-mentioned papers, latest developments in other fields of welding activity will be reported. These include welding of titanium and zirconium; brazing stainless steels and high-temperature alloys; new techniques in precision welding control; filler metals for welding high-strength steels; zinc soldering of aluminum; welding of missile airframes; and the use of welding in foundries.

Two sessions devoted to the latest advances in welding research, will include factors affecting weld toughness and the influence of design on brittle fractures.

All technical sessions will be held at the Hotel Sheraton, AWS Headquarters for this meeting. The Welding Show, featuring exhibits and demonstrations of the latest equipment, filler metals, and supplies used in the welding industry, will be located at Convention Hall.

Eighth Pittsburgh Conference

THE Eighth Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy will be held at the Penn-Sheraton Hotel in Pittsburgh, March 4 through March 8, 1957. Co-hosts will again be the Analytical Chemistry Group of the Pittsburgh Section of the American Chemical Society and the Spectroscopy Society of Pittsburgh.

Primary objectives of the Exposition held in conjunction with the Conference are to acquaint visitors with the most recent developments in laboratory equipment and to provide an opportunity to discuss needs.

Force and Weight Standards Gain New Importance in Industry

By Arthur C. Ruge

New possibilities in the utilization of basic standards of force and weight measurement are offered by the National Bureau of Standards as a result of its development of several new type portable calibration instruments. This equipment increases the Bureau's capacity for force and weight calibration of measuring systems to 12,000,000 lb. Load-measuring systems in capacities from 300,000 to 3,000,000 lb can now be calibrated by means of a single load-sensitive unit. This development is believed to be of equal importance with the commonly used proving ring[1] which was developed in the Bureau laboratories by H. L. Whittemore and S. N. Petrenko nearly 40 years ago. Proving rings now range in capacity from 300 to 300,000 lb in compression and up to 100,000 lb in tension. Although several 300,000-lb capacity proving rings can be used together to calibrate testing machines of larger capacity, there is a limit to the practicability of this procedure.

The testing and calibration activities of NBS stem from its custody of the Nation's basic physical standards. Accuracy and uniformity in measurements throughout the United States depend on these standards. Congress accordingly authorized the Bureau to engage in testing and calibrating services, particularly when sufficient accuracy cannot be obtained elsewhere.

The Bureau's service is unique and of inestimable value to the users and manufacturers of precision force and weight measuring equipment. The Bureau is the only place in the United States where the highest accuracy is available in the calibration of secondary calibration equipment for checking the accuracy of weighing and force measuring devices.

The Bureau does not compete with commercial testing laboratories. Restrictions are necessary in order to utilize the precision equipment only for calibration of the working standards in research laboratories and industry. Use of the equipment is limited to such tests as the comparison of laboratory standards or instruments with national standards and to tests of such devices and materials as are critical in industrial or laboratory operations.

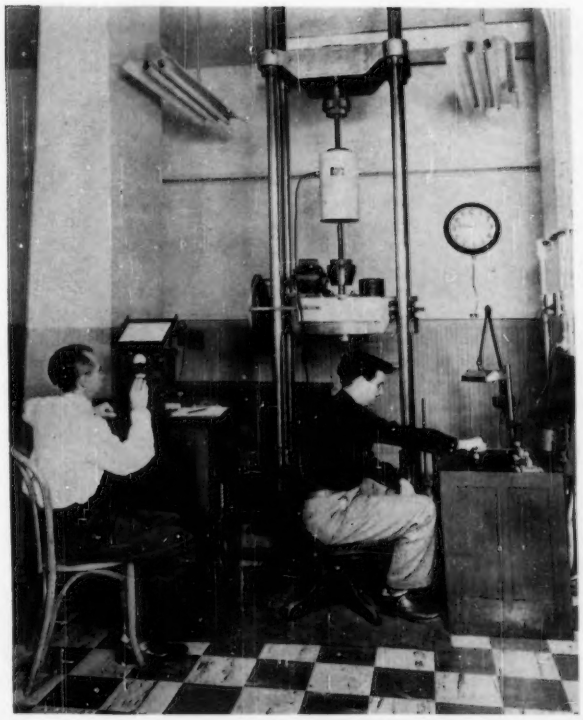


Fig. 1.—Calibration of a 1,000,000-lb Capacity Baldwin SR-4 Load Cell in Tension.

Calibration at the National Bureau of Standards, Washington, D. C., on the 111,000-lb capacity dead-weight machine. Calibration of load sensing devices incorporating resistance wire strain gages now comprises 30 per cent of the calibration work done.

This load cell and calibration indicator (left) will be used in tension and compression as a secondary standard for the calibration of testing machines, weighing scales, or other force-measuring equipment.

New Method is Electrical

New calibration methods have now been made possible by the development of the bonded resistance wire strain gage. It offered an electrical means of sensing changes in high forces with the required accuracy and sensitivity for calibrating testing machines, weighing scales, and other load-measuring systems. Electronic amplification is commonly used with indicating instruments. Since these gages respond primarily to very minute strain rather than to perceptible mechanical deflection, the use of an elastic compression element in the form of a column permitted the development of a compact, efficient, high-capacity load-sensing unit for electrical measurement of loads greater than 300,000 lb in a single unit.

ARTHUR C. RUGE, president, Arthur C. Ruge Associates, Inc., Lexington, Mass., was one of the inventors of the resistance wire strain gage, now known as SR-4.

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[1] B. L. Wilson, D. R. Tate, and G. Borkowski, "Proving Rings for Calibrating Testing Machines," Circular of the National Bureau of Standards C 454 (1946).

The development of the Bureau's strain gage type calibration equipment was initiated by Lyman J. Briggs, director emeritus of NBS, under the direction of B. L. Wilson and D. R. Tate.[2] Their objective was to achieve a stability and accuracy equal to that of the proving ring, or about 0.1 per cent. The Bureau profited to some extent by the fact that load cells in a wide range of capacities had already been developed by Ruge-deForest Inc. for Baldwin-Lima-Hamilton Corp. These are used for such varied purposes as weighing the contents of tanks, bins, and hoppers, measuring forces such as the thrust of rocket engines, Prony brake loads, etc., and serving as load-sensitive devices in the automatic control of machinery.

The NBS strain gage dynamometers are essentially solid steel columns with eight resistance wire strain gages equally spaced around their centers. Four are bonded to the column longitudinally 90 deg apart and the other four are bonded in transverse positions. The column is flared out at top and bottom to enlarge the bearing areas and a cylindrical protective metal cover is held in place by setscrews through retaining rings around the enlarged ends of the column. The strain gages are connected together to form Wheatstone bridge circuits and a conventional type Baldwin SR-4 strain indicator was modified as a load-indicating device.

Over a period of several years strain gage dynamometers of 100,000, 300,000, 1,000,000, and 3,000,000 lb were built by NBS. These include four each of the two largest sizes. Their accuracies meet the requirements of ASTM Method E 74–55 T[3] which provides tolerances of 0.4 per cent for 3,000,000 lb and 0.3 per cent for 1,000,000 lb. The largest dynamometer weighs about 225 lb which permits easy handling by two men, and its rugged construction permits handling on hand trucks or by crane. The 1,000,000-lb dynamometer weighs only about 30 lb. Associated electrical instruments are also readily portable.

Advantages in All Capacities

Although these high-capacity dynamometers were developed primarily to extend the range of capacity beyond that of proving rings, they have been found to have characteristics which make this method advantageous in lower capacities also. Their principal advantage in

[2] D. R. Tate, "Application of Resistance-Wire Strain Gages to High Capacity Load Calibrating Devices," Circular 528 of the National Bureau of Standards (1954)

[3] Tentative Method of Test of Verification of Calibration Devices for Verifying Testing Machines (E 74–55 T), 1955 Book of ASTM Standards, Part 1, p. 1668, Part 2, p. 1339, Part 3, p. 1916, Part 4, p. 1294, Part 6, p. 1642, Part 7, p. 1581.

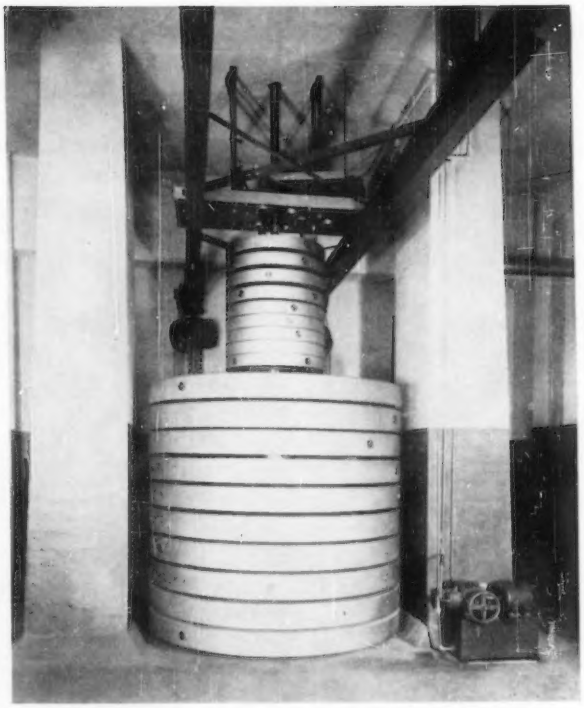

Fig. 2.—Weights Used in Calibrating the Load Cell in Fig. 1.

The weights shown here are under the testing machine at the National Bureau of Standards. The maximum error in the mass of any one of the 10,000-lb weights or lower frame is about 1.0 lb and that of the 1000-lb weights is 0.05 lb.

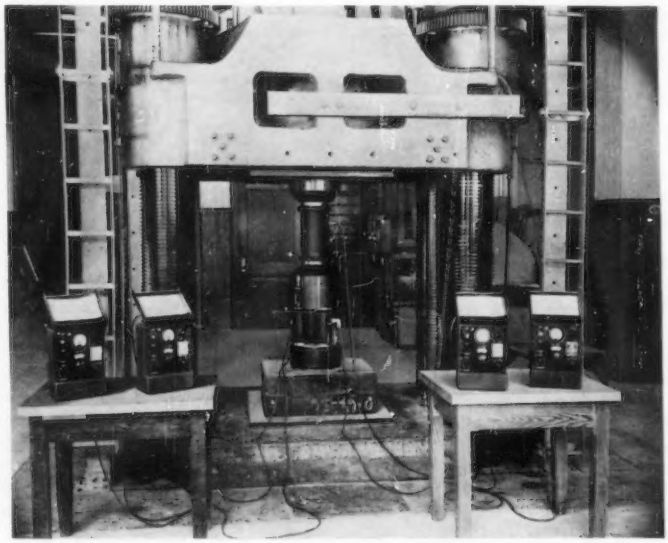

Fig. 3.—Calibrating a New 3,000,000-lb Strain-Gage Dynamometer.

A new 3,000,000-lb strain-gage dynamometer, designed by the NBS, is being calibrated in a 10,000,000-lb testing machine, the largest in the world, by means of three 1,000,000-lb dynamometers that were previously calibrated.

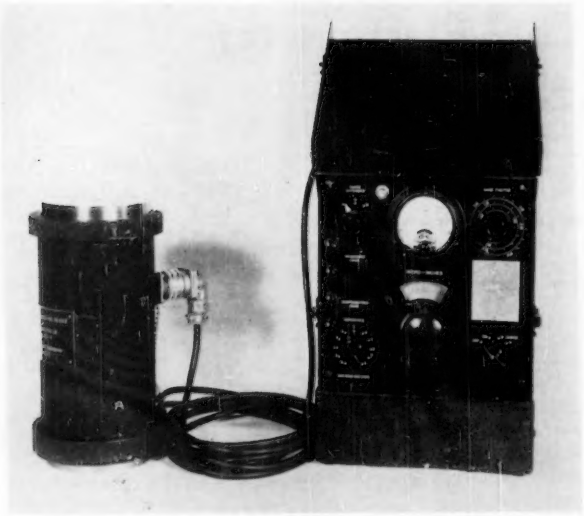

Fig. 4.—This Million-lb, Strain-Gage Type Dynamometer and Electrical Load Indicator Is One of Four Units Constructed by the NBS in This Capacity.
The dynamometer weighs only 30 lb.

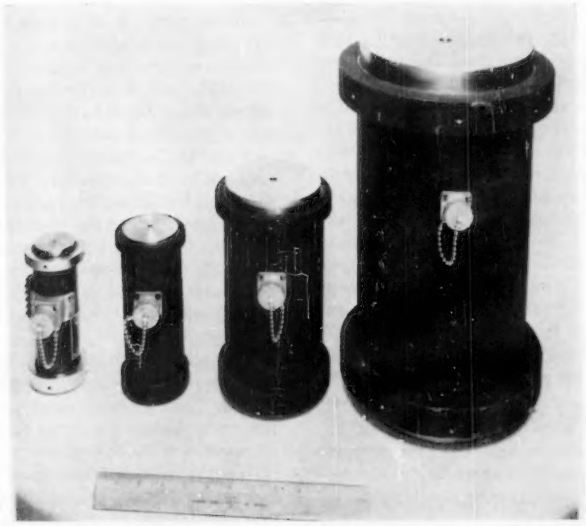

Fig. 6.—Over a Period of Several Years Strain-Gage Dynamometers of 100,000, 300,000, 1,000,000, and 3,000,000 lb Were Built by the National Bureau of Standards.

high capacities is expected to be in reducing the time for calibrating a testing machine of 10,000,000 lb to one-fourth and the cost to one-half that formerly required in calibrating a testing machine of only 2,500,000 lb. capacity.

Much less skill is required of the operator to obtain satisfactory readings under loads that are changing rapidly or that transmit considerable vibration. Furthermore, measurement of load can be made at a remote point. Also, the scale division corresponding to capacity load may be adjusted to match any desired interval.

Although the present measuring instruments are adequate in sensitivity and ease of handling, it is believed that it will be possible further to improve their quality and design to meet the special requirement of this type of service. It is expected that such improvements will eliminate difficulties in producing the required high degree of stability in the strain gages and the measuring circuit and the relative complexity and high cost of the electrical components.

[4] B. L. Wilson, D. R. Tate, and G. Borkowski, "Deadweight Machines of 111,000 and 10,100-Pound Capacities," Circular of the National Bureau of Standards C 446 (1943).

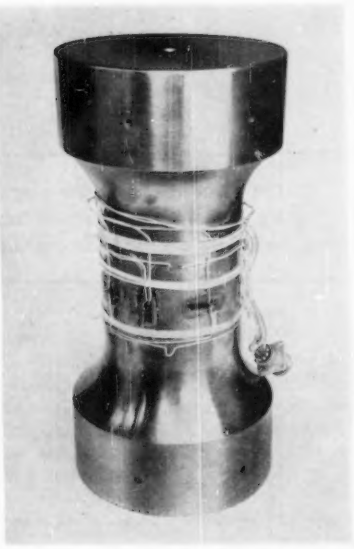

Fig. 5.—3,000,000-lb Strain-Gage Dynamometer.

This dynamometer is essentially a 225-lb solid steel column with eight resistance wire strain gages bonded at mid-height; four parallel to and four perpendicular to the longitudinal axis. Large bearing areas are provided by flaring top and bottom. Tapped holes in the rims are for set-screws in two retaining rings that hold a cylindrical cover in place.

Of significance in connection with the development of new type calibration equipment is the fact that until about 1950 approximately 90 per cent of the elastic calibration devices submitted to Bureau of Standards for calibration were proving rings. Now the volume of calibration work has increased about 100 per cent and load sensing units based on resistance wire strain gages comprise about 30 per cent of the calibration devices and force-measuring units submitted for calibration.

Since the capacities of most of these units are under 100,000 lb they can be calibrated on one or the other of the Bureau's two dead-weight testing machines.[4] These were installed after the development of proving rings to provide a means of applying accurately known forces to calibrate these instruments. These machines have capacities of 10,100 and 111,000 lb.

Present practice is to calibrate load-sensitive devices having capacities between 300,000 and 1,000,000 lb by means of calibrated proving rings in a testing machine of adequate load capacity. Load-sensitive devices having capacities between 1,000,000 and 10,000,000 lb are calibrated at the Bureau by means of the 1,000,000 and 3,000,000-lb strain gage type dynamometers.

A New Coal Plastometer

By Donald C. Hills

The author believes the new plastometer is less subject to bearing, slippage, and frothing troubles, and faster, more convenient, and more precise than the Gieseler.

Fusibility is the essential property of coking coals. When heated slowly, as in a coke oven, some coals fuse completely, some partly, and others not at all. Fusibility is favored by rapid heating; weathering has an adverse effect. The consistency of the mass of coalescing coal particles is related to fusibility and is called plasticity or fluidity.

Brewer (1)[1] has described many of the various instruments that have been used in measuring, or in attempting to measure, this essential property of coking coals. Included are the Davis constant speed–variable torque and the Gieseler constant torque–variable speed plastometers. Barthaur (2) has recently designed an instrument based on the Davis principle.

The Gieseler apparatus is at present probably the one most widely used in the United States. In its retort, a sample of coal is packed around rabble arms on a stirrer shaft. Constant torque is applied as the coal is heated at 3 C per min in a lead bath. There is a bearing in contact with the coal at the bottom of the retort. Above, a sleeve bearing and a heavier shaft turns in two ball bearings from the force of a weight on a string wound around a drum and passing over a pulley equipped with a pointer.

In 1942 this laboratory obtained a Gieseler plastometer built essentially according to the design then in use at the Bureau of Mines. During ten years' experience with this instrument certain basic difficulties were repeatedly encountered. At times the packing failed to hold and the weight would drop as if free. At other times air-borne dust particles were suspected of causing the bearings to freeze. The necessity of rewinding the string caused unavoidable differences in experimental conditions.

Also, there was the apparently incurable tendency of highly fluid coals to froth. Stirrer rates with frothing coals were probably excessively high because a substantial part of the sample moved away from the rabble arms. In many cases it was necessary to make stop watch readings of less then 1 sec on a rapidly turning pointer. Chances for error were manifold.

In 1949, Subcommittee XV on Plasticity and Swelling of Coal of ASTM Committee D-5 on Coal and Coke sponsored cooperative work (3) among laboratories using the Gieseler plastometer, in which the Citizens Gas and Coke Utility laboratory participated. Silicone oils were used for attempted standardization. Resulting data were unconscionably wide. However, some of the instruments were probably not in the best possible working order because the users had become discouraged by inherent difficulties. Agreement might have been better had there been fewer modifications designed to improve results.

Considerable effort has been made in an attempt to design a more convenient and reliable instrument. The period of development has covered about four years. This paper reviews some of the variations tried in the development stage.

Development

Those features of the Gieseler plastometer which were retained as desirable were the 3 C per min heating rate, the dial with 100 divisions, and the constant torque. The most important novel concepts incorporated in the new plastometer are: method of packing, test assembly, torque application, and method of heating.

Packing Method

When coal is heated, a preliminary shrinkage occurs prior to actual fusion. It is virtually a necessity to pack the sample sufficiently to prevent the premature release of the rotor during this shrinkage: otherwise the resulting agitation of the sample, while still granular, may in some cases prevent subsequent fusion.

The original Gieseler packing, effected by 15 min of dead weight pressure on a piston, was found unsatisfactory. There were too many premature releases. Fewer failures were obtained by dropping a smaller weight a specified distance ten times on the main packing weight. A more rugged piston guide was designed to withstand the impact.

With the new plastometer, packing is simpler and more effective. The covered retort, with rotor in the sample, is placed in a guide, Fig. 1, and dropped ten times from a height of 1 in. on a steel plate. An exact 1.0-in. drop is not essential. Drops of 2.5 and 0.5 in. were also effective. There was no significant difference in test results between 2.5 and 1.0-in. drops, and little or none between 1.0- and 0.5-in. drops.

When packing is complete by this dropping procedure there is no piston to withdraw, the cover is already in place; hence the risk of disturbing the packing is lessened. There have been no failures with this method with the ordinary coals received in this laboratory. An especially difficult sample for the Gieseler obtained from the Illinois State Geological Survey through the courtesy of E. D. Pierron, failed under 0.8-oz in. torque using 3 g but was successfully tested in duplicate using 5 g. It was again tested successfully under 0.4 oz in. torque using 3 g.

The elimination of the piston permits important changes in test assembly design. The bottom bearing for the rotor may be removed from the coal and integrated with the cover. A removable set of metal strips may be placed against the inner wall of the retort to prevent slippage.

DONALD C. HILLS, chemist, Citizens Gas and Coke Utility, Indianapolis, Ind., has worked a number of years on plasticity and expansion of coal. Currently he is working on a simplified torque application for the plastometer.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

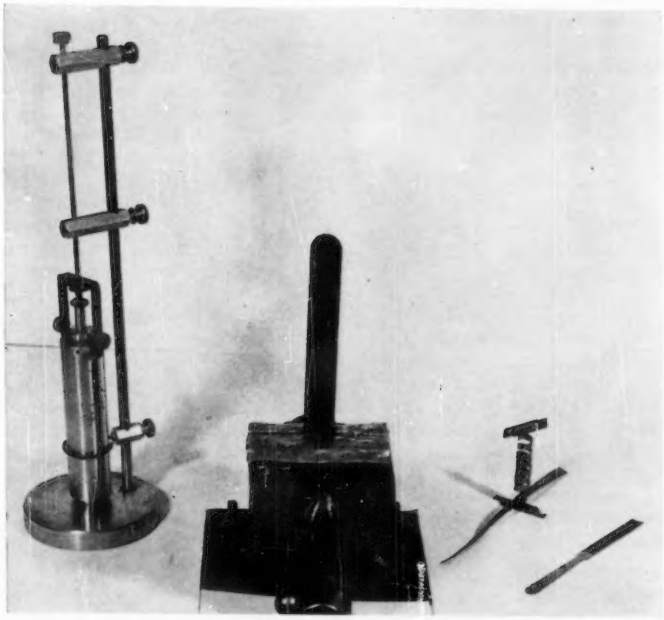

Fig. 1.—Packing Guide, Cleaning Tools and Calibrating Spring.

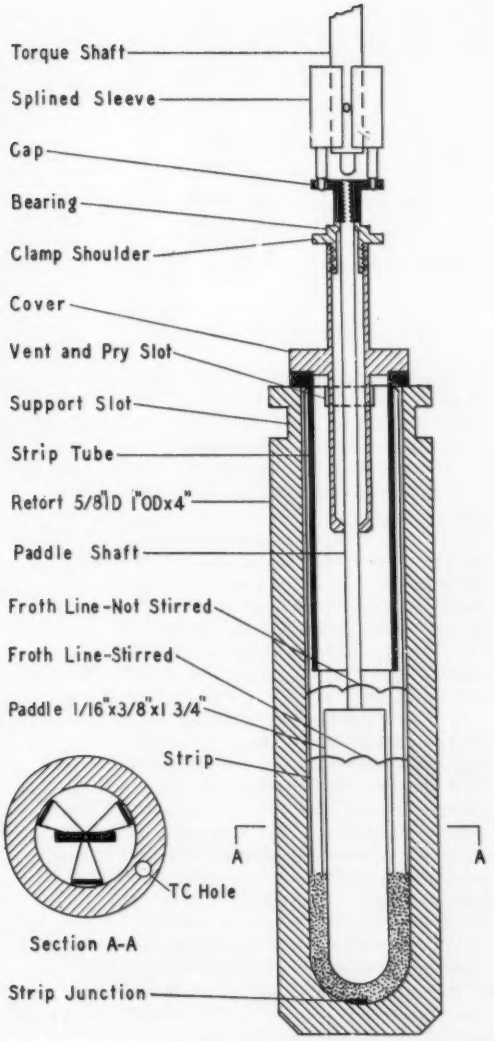

Fig. 2.—Details of the Test Assembly.

Test Assembly

Logically, an efficient apparatus for measuring the rate of shear in a material must not permit slippage between the material and the apparatus. This requirement should be met by the test assembly, which consists of two essential parts: the retort and the rotor with bearings.

(*a*) *The Retort.*—Retorts of steel, aluminum, and brass were tried. Steel was not adopted because of its relatively poor thermal conductivity and machinability. After a few dozen tests with aluminum retorts, progressive decrease in length and distortion in circular section demonstrated that this metal was too soft. Brass was found to be dimensionably stable. It had satisfactory thermal conductivity. It could be readily drilled for small deep thermocouple holes. At this writing two brass retorts have a proved life of over 300 tests each. A conservative estimate of their useful life would be 2000 tests.

After several modifications, the brass retort has reached a final form as shown in Fig. 2. It is made by drilling a $\frac{5}{8}$-in. hole in a 1-in. round brass piece 4 in. long. The bottom of the hole is finished hemispherically with a ball-end mill, leaving a minimum of $\frac{3}{16}$-in. at the bottom and side. One or more $\frac{3}{32}$-in. holes are drilled down through the side to mid-sample level for thermocouples. A slot in the top at the back serves as a vent and as an entrance for a screw driver for removing the antislip strips and cover.

The advantages of this one-piece construction are considerable. There are no threaded parts requiring pretreatment with graphite and oil to make disassembly possible, thus eliminating a possible source of contamination. The rounded bottom permits a more uniform distribution of sample upon packing. There is no bearing in the fused coal. The retort may be cleaned readily using the flat rounded-end tool of hardened steel shown in Fig. 1.

Brewer (1) described Macura's cylindrical retort whose hemispherical bottom and inside wall were cut by triangular grooves with the evident purpose of preventing slippage. The author's design provides a removable assembly of three $\frac{1}{32}$- by $\frac{3}{16}$-in. steel strips brazed to the sides of a flanged tube. The strips fit longitudinally against the retort inner wall. The lower ends are tapered, curved, and joined by brazing, so that they fit against the hemispherical bottom.

A comparison between test results with strips and without strips is shown in Fig. 3; a more regular curve was obtained using strips. There are irregularities in the curve near the maximum for the test without strips which may be attributed to slippage.

(*b*) *The Rotor with Bearings.*—Experience had shown that certain coals inevitably frothed. Therefore, only those rotor designs were considered which had a uniform cross-section in the frothing zone. Steel, brass, aluminum, and transite rotors of various shapes were tried. If the cross-sectional area of metallic rotors exceeded a certain limit, the top layers of low fluidity coals were found unfused at the end of the test. A steep temperature gradient was the probable cause. With transite rotors, fusion was complete.

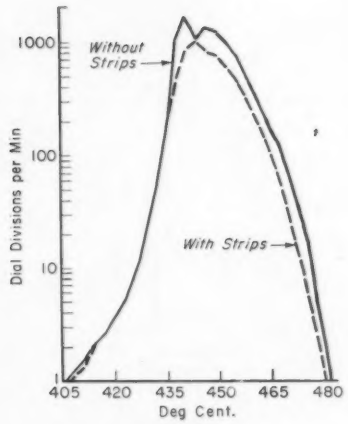

Fig. 3.—Effect of Wall Strips.

Transite rotors with round, octagonal, hexagonal, and square cross-section were tried. All round rotors slipped. Smaller sizes of transite were too fragile. Larger sizes were subject to a peculiar frothing trouble with fluid coals. One or two worm-like extrusions, sometimes exceeding 2 in. in length, were frequently found in the upper space between rotor and retort wall.

A large majority of the frothing coals so far tested never rise above the paddle part of the steel rotor (Fig. 2) now in use. This statement would probably be true for virtually all coals if the paddle part were $\frac{1}{8}$-in. longer. There have been no unfused top layers and much less "*worm*" formation when this rotor is used with antislip strips. The paddle part is $\frac{1}{16}$ by $\frac{3}{8}$ by $1\frac{5}{8}$ in. ($1\frac{3}{4}$ in. preferred). The bottom of the paddle is rounded to conform to the hemispherical bottom of the retort. The antislip strips are designed so that a uniform total clearance of the paddle edges is maintained to provide smooth rotation. As the paddle turns from the position shown in Fig. 2, Section A-A, one edge approaches as the other edge recedes from a strip.

One end of a $\frac{3}{32}$-in. steel shaft is brazed to the paddle. The other end is cut to length and provided with an accurately located shoulder, 0.25 in. from the end, by threading the suitably reduced diameter. The steel cap, shown in Fig. 2, screws down against this shoulder and supports the paddle $\frac{3}{32}$ in. above the strip junction by contact with the upper brass bearing. The paddle and shaft are held in an alignment jig when brazed. They are occasionally checked for straightness in the same jig and have held alignment well.

The top bearing screws into a brass housing which is integral with the bottom bearing and the cover. Thus, when assembled, the top bearing is 1 in. above the cover outside the retort and the bottom bearing is 1 in. below the cover within the retort. The parts are drilled so that the shaft is in contact with brass for only about $\frac{1}{64}$ in. at each of the bearing points.

These bearings have never frozen during a test and operate satisfactorily without oil of any kind. The torque required to start the paddle turning in an empty test chamber at room temperature was found to be 0.02 oz in. as measured by the deflection of a fine piano wire. This is 2.5 per cent of the working torque (0.8 oz in.). A Gieseler with bearings freshly cleaned and oiled and in optimum condition requires about 7.5 per cent for the corresponding test.

Torque Application

Torque is produced by a General Electric hysteresis brake[2] mounted in a Gimbal ring, shown in Fig. 4, which is motor-driven at about 270 rpm. At stabilized temperature the torque is essentially constant over a wide range of speeds. The torque loss due to temperature rise during a test is limited to less than 2 per cent by thermal insulation and air cooling. The brake is calibrated by test weights, as shown in Fig. 4., to 0.80 ± 0.01 oz in. Routine torque checks may then be made using a calibrated phosphor bronze spring.

It was found impractical to eliminate all torque shaft eccentricity with the adjustable Gimbal ring mounting. Eccentricity was found to change with the torque setting. The residual oscillation caused spurious counts when a simple brush counter contact was operating on the shaft. A successful counter contact was made which uses the snap action of very light phosphor bronze strips to make and break a platinum wire contact.

Heating Method

Automatic temperature control is

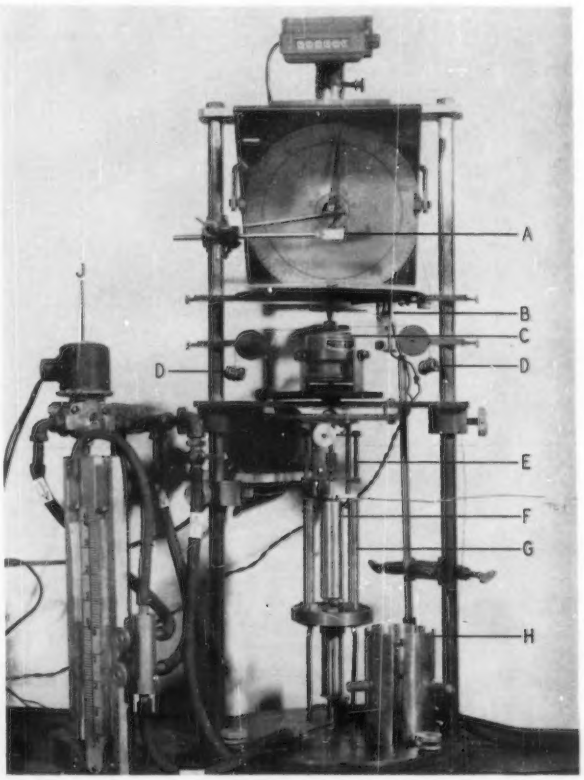

Fig. 4.—Plastometer with Reflectors Arranged to One Side.

A—Calibrated spring support
B—Counter contact
C—Hysteresis brake
D—Test weights
E—Sliding frame
F—Retort
G—Burner
H—Reflectors
J—Solenoid valve

[2] The brake was modified by providing a new torque shaft with both upper and lower extensions. A pointer was attached to the upper extension. The pointer and the scale beneath it are observed through an adjustable mirror. Before the hysteresis brake became available a more complicated friction brake was used.

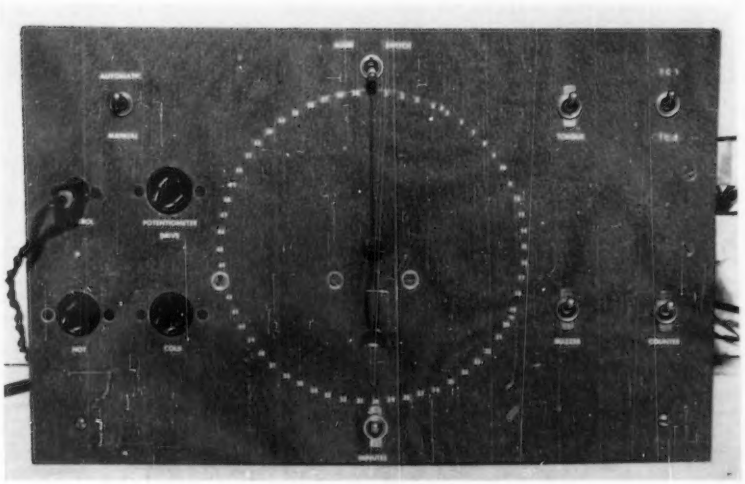

Fig. 5.—Control Panel.

much more convenient than manual control. The control panel, shown in Fig. 5, has provisions for either method. For automatic control, a solenoid gas valve is operated by a hot or cold signal from a contact advanced 3 C per min by a gear train on a Speedomax recording potentiometer. For manual control, a needle valve is operated as required to restore balance in a portable potentiometer driven by a timing motor. Figure 6 shows typical time-temperature records for both methods. No significant difference in results was found in duplicate tests between automatic and manual control, provided the automatic solenoid valve was mounted separately, since its vibration was found to speed the rotor slightly with low-fluidity coals. Supporting data are given in Table I.

Uniform temperature, to the top of the frothing zone, is certainly not attained by the partial immersion of the heavy steel Gieseler assembly in a lead bath. Due to its many disadvantages it was decided to eliminate the lead bath. Heating with electricity and heating with gas were investigated experimentally.

(*a*) *Heating with Electricity.*—A refractory tube wound with one layer of resistance wire and surrounded with thermal insulation proved incompatible with the recording potentiometer. It was necessary to double back another layer of resistance wire and tune out the remaining induction with a shunt to prevent a-c pickup in the sensitive thermocouple circuit. With full current, operating temperature could be attained in a reasonably short time; but when it was desired to slow down to 3 C per min, it was necessary to direct a strong air blast at the bottom of the retort to prevent overshoot. Figure 6 shows that a good temperature control could then be obtained with automatic operation of small changes of air and heating current.

(*b*) *Heating with Gas.*—Sufficient uniformity of temperature with gas heating was considered doubtful; therefore the first attempt was made with a rotating U tube burner. After the mechanical difficulties were solved it

TABLE I.—EFFECT OF HAND AND AUTOMATIC CONTROL ON MAXIMUM DIAL DIVISIONS PER MIN.

Sample	Maximum Dial Divisions per min		
	Hand Control	Automatic Solenoid on Frame	Automatic Solenoid off Frame
A	8.2 (2)[a]	8.4 (2)[a]	...
A	7.5 (3)[a]	...	...
A, average	7.85	8.4	...
B	29.5 (2)[a]	33.2 (3)[a]	...
B	30.4 (3)[a]	32.0 (3)[a]	...
B, average	29.95	32.6	...
B-1	...	32.8 (3)[a]	30.0 (2)[a]
C	13 600 (2)[a]	13 100 (2)[a]	...
C	13 100 (3)[a]	...	13 100 (3)[a]
C, average	13 350	13 100	13 100

[a] (2) and (3) indicate assembly numbers. All tests were made by the same operator using gas heat. Average of temperature differences for start, maximum, and stop was 0.9 C.

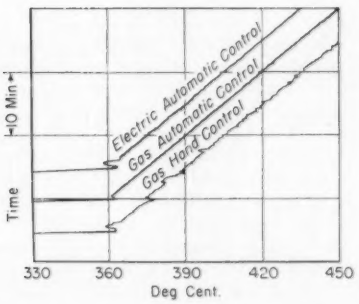

Fig. 6.—Time-Temperature Records.

was discovered, by making check tests with the burner stationary, that rotation was not essential. It was then considered advisable to try a four-tube stationary burner, but with this design adequate tube size prevents side insertion of the retort; therefore a three-tube burner was adopted, shown in Fig. 4. There are 17 ports in each tube and 3 ports in the base equi-spaced between tubes. The tubes are adjustable radially for length of flame and are removable for changing port area. The burner orifice and air shutter setting may be readily changed. Adaptation to various fuel gases should be possible.

The three aluminum reflectors, shown arranged to one side in Fig. 4, clip on the burner tubes when in use. Flame inspection is possible between edges of the reflectors, but a more important function of these three spaces is to provide increased uniformity of temperature. At mid sample level, the temperature in the retort wall, midway between burner flames, was found to be lower than at the burner flame without reflectors, higher with reflectors all around, and within 2 C with about 15 per cent radiation space as shown in Fig. 4. This arrangement also improves the vertical temperature gradient. Up to twice the sample depth no variation over 2 C was found.[3]

Equipment and procedure are simplified with the use of gas. The flow through the solenoid valve is by-passed by one needle valve, throttled by another, and indicated by a U-tube pressure gage. There is no wait to build up temperature before starting and no overshoot when slowing down to 3 C per min. Since only a few adjustments of the needle valves are required, the operator has ample time for recording observations. Operating temperature range is reached in about 4 min. The interval between tests may be reduced to about 3 min by using compressed air for cooling.

[3] Measurements were made with the Speedomax by momentarily switching to a second thermocouple during regular tests with a 3 C per min heating program.

Procedure

A representative sample is stage crushed to pass a 420-micron (No. 40) sieve in such a manner as to minimize production of fines. Precautions are taken to minimize oxidation. Samples are stored in tightly capped bottles under refrigeration. They are mixed 15 min on a rotating wheel. Three grams, weighed to the nearest 0.01 g, are brushed through a funnel into a cleaned retort with antislip strips in place. The paddle is not pushed down into the sample until the cover is in place. The assembly is then placed in the packing guide, Fig. 1, and dropped ten times from a height of 1 in.

The calibrated torque spring, shown in Fig. 1, may be used to check the torque before and after a test. With the torque spring removed the assembly is clamped in place and the torque shaft is turned until the pins on the splined sleeve engage the holes in the cap. The dial is turned until its zero is under the shaft pointer. The electric counter is set to zero and the counter contacts are set to engage when testing fluid coals. The thermocouple is placed in the test chamber wall. The burner is operated at sufficient pressure to heat to (*a*) 360 C in 3 to 3½ min for fluid coals, (*b*) 405 C in 3½ to 4 min for low-volatile coals with high starting temperatures. Subsequent heating proceeds at 3 C per min under automatic control with the average burner pressure about half that at the start.

The decomposition gases are ignited by the rear burner and the products of combustion are removed by a slight vacuum in a small pipe the end of which is placed near the vent hole. A small stream of compressed air is used to cool the hysteresis brake. When making a series of tests, using alternate retorts, it is advisable to remove the hot retort immediately at the end of the test to prevent unwanted heating of the brake.

Total dial divisions are read every minute at the end of a 4-sec buzzer signal. The 1-sec signal at the half minute point is used when it is desirable to check temperature with the schedule. The test is stopped when the increase in the dial reading over the previous minute falls to one dial division or less. The increase in the dial reading for a given minute is plotted against the midpoint temperature for that minute. The temperature of the start is taken where the line rises above one, the end where it falls below one dial division per minute.

A screw driver in the vent slot serves to loosen the antislip strips. The strips, paddle, and most of the semicoke may then be removed by hand. The paddle is cleaned with a small flat file. The shaft is polished with crocus cloth. The bearings are checked with a utility shaft. They are occasionally cleaned with this shaft coated with fine abrasive and oil. The antislip strips are cleaned with the small flat file. The retort is cleaned with the flat round ended tool shown in Fig. 1.

The cleaning and packing operations may be completed while cooling with compressed air between tests. Tests may be made at the rate of one per hour. This includes all calculations but not the plotting of a curve.

TABLE II.—DUPLICABILITY OF RESULTS WITH THE NEW PLASTOMETER.

Sample	Operator	Assembly	Dial Divisions		Temperature, deg Cent.			
			Maximum per min	Total	Start	Stop	Range	At Max dial divisions per min
LV	P	2	22.3	166	437	497	60	480
LV	P	3	22.2	167	438	499	61	480
LV	L	1	20.3	159	438	501	63	480
LV	L	2	22.5	170	438	498	60	480
LV	H	1	20.9	162	440	500	60	480
LV	H	3	22.2	167	438	499	61	480
X, $n = 6$	..	..	21.7	165	438	499	61	480
σ	..	..	0.8	3.6	0.9	1.3	1.1	0
$v = \frac{100\,\sigma}{X}$	..	..	3.8	2.2	...	...	...	...
Blend	P	1	880	6 160	407	487	80	450
Blend	P	2	890	6 160	406	485	79	450
Blend	L	1	875	6 100	407	486	79	450
Blend	L	3	910	6 550	407	485	78	447
Blend	H	2	900	6 410	405	484	79	450
Blend	H	3	965	6 860	406	485	79	447
X, $n = 6$	..	..	903	6 370	406	485	79	449
σ	..	..	30	269	0.7	0.9	0.6	1.4
$v = \frac{100\,\sigma}{X}$	..	..	3.3	4.2	...	...	...	...
HV	P	1	9520	70 800	387	489	102	447
HV	P	3	9550	71 500	386	489	103	450
HV	L	2	9000	68 700	386	486	100	447
HV	L	3	9650	72 400	388	488	100	450
HV	H	1	9300	69 200	387	488	101	450
HV	H	2	9400	70 800	384	485	101	447
X, $n = 6$	..	..	9400	70 600	386	487	101	448
σ	..	..	212	1 290	1.2	1.5	1.1	1.5
$v = \frac{100\,\sigma}{X}$	..	..	2.3	1.8	...	...	...	...

Performance

Convenience of operation was considered an essential requirement in design. In order to evaluate both duplicability and convenience, three coals were selected on which duplicate tests were made by three operators using three test assemblies. To minimize oxidation effects, the six tests on a given coal were completed in one working day. Each operator used a different test assembly for his second test. The schedule of 18 tests was completed with each operator using each test assembly twice. Test assembly No. 1, the prototype, had been used 15 times. No. 2 and No. 3 had each been used over 200 times. Results, given in Table II, show possibilities for quantitative interpretation.

Duplicability of results was considered the most important requirement in the design of the new instrument. For comparison, the results of some of the duplicate tests made with the Gieseler apparatus at this laboratory by one operator are given in Table III. Only three of the 20 pairs check within 10 per cent or better. These results together with similar data by Rees and Pierron (4) show possibilities for qualitative interpretation only.

Six measurements made under essentially the same conditions may be arranged in 15 possible combinations of two each, each of which is essentially equally probable. The per cent difference of each of the 15 possible combinations of the three sets of the new plastometer data was calculated by the same formula used for the Gieseler data. The averages are compared in Table III. It is believed that any bias in this comparison favors the Gieseler apparatus.

As did Rees and Pierron (4), this laboratory has tried mixing an inert material with a frothing coal and found that such practice results in less duplicability with Gieseler tests. The reason may be that the wetting power of the coal is reduced by the diluent. This could cause more harm due to slippage than benefit due to the observed reduction in frothing. It was thought that the smoother curve, shown in Fig. 3, might be the result of reduced frothing turbulence effected by increased stirring action with wall strips. However when a similar sample, the blend in Table II, was tested at an increased

TABLE III.—DUPLICABILITY OF GIESELER MAXIMUM FLUIDITY COMPARED WITH THE NEW PLASTOMETER.

Gieseler Duplicate Tests								
Low-Range Coal			Medium-Range Coal			High-Range Coal		
Maximum Dial Divisions per min		Per cent Difference	Maximum Dial Divisions per min		Per cent Difference	Maximum Dial Divisions per min		Per cent Difference
11.3	11.9	10.1	720	1 090	40.9	7 500	12 000	46.2
11.6	15.6	29.4	1000	1 280	19.4	12 000	15 000	22.2
45.0	49.7	9.9	2100	3 000	35.3	20 000	30 000	40.0
368	469	24.1	3750	4 620	20.3	20 000	30 000	40.0
385	492	24.4	6000	7 500	22.2	20 000	30 000	40.0
395	515	26.4	6000	10 000	50.0	30 000	30 000	0.0
			8600	10 000	15.1	30 000	40 000	28.6
Gieseler average		20.7			29.0			31.0
New plastometer 15 pairs, Table II		4.7			4.0			2.9

Over-all per cent difference Gieseler average 26.9
Over-all per cent difference new plastometer average..... 3.9

$$\text{Per cent difference} = \frac{100 \times \text{numerical difference}}{\text{Average of pair}}$$

TABLE IV.—EFFECT OF TORQUE ON DUPLICABILITY WITH BLEND.

Torque, oz in.	Number of Tests	Maximum Dial Divisions per min			Temperature, deg Cent.				Froth Level
					At Start		At Maximum Dial Division per min		
		Average	Standard Deviation	Coefficient of Variation	Average	Standard Deviation	Average	Standard Deviation	
1.6...	4[a]	2350	189	8.0	397	1.8	447	2.4	High
0.8...	6[b]	903	30	3.3	406	0.7	449	1.4	Medium
0.4...	6[a]	423	6	1.5	412	0	450	0	Low

[a] Same operator with the same test assembly. One test at both torque levels completed for froth comparison.
[b] Three operators with three test assemblies. Data from Table II.

stirring rate by doubling the torque, momentary variations in rate were observed and the frothing level and the coefficient of variation were increased. Better results were obtained with one half the original torque. These tests were made by one operator using the same test assembly and were usually stopped after reaching maximum to save time. A comparison is given in Table IV.

Inspection of the residues from completed (Table IV) tests provided explanations for (*a*) the anomalous froth levels and (*b*) the decreased duplicability with higher torque. With the highest torque, very little material had adhered to the paddle, the cylindrical path of the paddle was virtually empty; hence the froth had been forced to a higher level. With the lowest torque much of the material had remained in the path of the paddle. The presence of strips may have prevented wall slippage, but with the highest torque it was evident that the paddle edge could readily have been slipping. The rabble arm construction and intermittent torque of the Gieseler does not necessarily prevent this displacement. The author has observed Gieseler residues in which the rabble arm area had been completely cleared of sample.

The blend sample, Tables III and IV, was tested at 0.4-oz in. torque without wall strips. A double peak was obtained, similar but less pronounced than the one in Fig. 3 which was found when a sample of the same class was tested without strips at 0.8-oz in. torque. The double peak did not occur on a duplicate test. A reasonable interpretation is that the start of wall slippage is imminent at the 0.4-oz in. torque level with a smooth wall. The corresponding shearing stress at the wall is about 0.017-oz per sq in. With the Gieseler apparatus the wall stress is almost four times this value. It is the author's opinion that high torque is the chief reason for the wide spread found in many Gieseler duplicate tests.

Brewer (1) observed that some coals may swell even more under load than when no load is applied. Such a system would be expected to be inherently unstable. With the new plastometer, momentary variations in rate become more apparent at higher torque even with highly fluid coals which cling to the paddle. The froth level of these coals is slightly reduced by higher torque. In this case, decreased duplicability at higher torque may be due to instability related to anomalous swelling, and wall strips might cause smoother action by

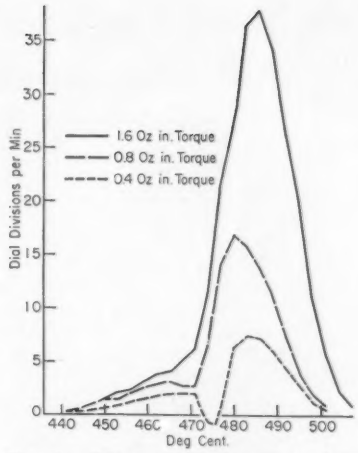

Fig. 7.—Effect of Torque on a Low Fluidity Test.

The paddle reversed direction with the low torque test. The high torque froth level was slightly lower

breaking up sufficient froth to reduce pressure to a more stable level.

A further advantage of reduced torque is shown in Fig. 7. The profile for the low-torque test is uniquely characteristic for a certain type of low fluidity coal. Uniqueness is lost in the high-torque test on the same coal.

Conclusion

The author believes that the new plastometer is faster and more convenient and, since it is less subject to bearing, frothing, and slippage troubles, that it is more precise.

Acknowledgment:

The author wishes to thank C. R. Holmes for encouragement and advice. R. J. Pauls and R. E. Leftwich assisted in testing and S. Johantges in the machine work. The author is grateful to the Citizens Gas and Coke Utility for permission to publish this paper.

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A Strain Gage for the Measurement of Strains in Adhesive Bonds*

By C. B. Norris, W. L. James, and J. T. Drow

A method is described for measurement of tensile strain in a thin adhesive bond between metallic adherends,[1] by measuring the change in the electrical capacitance of the specimen. Accurate evaluations of strain can be made if the effect of changes in glue-line thickness on the dielectric constant can be determined. For some adhesives, this effect may be calculated using the Lorenz-Lorentz equation relating dielectric constant to density, when density is assumed to vary inversely with the thickness of the glue bond.

THE STRENGTH exhibited by adhesives as they exist in bonds may be much greater than that exhibited by cast specimens of the same adhesives. This difference may have two causes, both related to the thickness of the adhesive film composing the bond. First, the deformations in the adhesive are restrained by the proximity of the adherends, and, second, a relatively large percentage of the adhesive has special physical properties because it has become solid in the neighborhood of an interface. Thus, in this study of the mechanism of adhesion, measurements were made of the strain in the direction of the thickness of a bond due to a tensile stress in the same direction.

The thickness of an adhesive bond may be about a thousandth of an inch, and the strain at failure may not be more than 2 per cent. To obtain smooth, reproducible stress-strain curves, the strain should be measured in units not greater than 0.001 per cent. This means that a change of a hundredth of a millionth of an inch (2.5 Å) in the thickness of the adhesive bond should be measured with reasonable accuracy.

The presently available mechanical-optical strain gages are not sufficiently sensitive for this purpose. Their smallest reading is in the neighborhood of a millionth of an inch, and it does not seem likely that refinements in their design could greatly increase their sensitivity. Further, such gages would have to be mounted on the bonded pieces at two points a large distance (compared to the thickness of the bond) from the bond, and could at best measure only the relative displacement of one of these points to the other. This displacement probably would not be equal to the average displacement of similar points within the specimen because of the perturbation of the strain pattern at the edge of the bond due to the Poisson's ratio effect. Reasonable measurements might be obtained by this method if the strain gage were mounted to bridge several bonded joints, and corrections made for the deformations undergone by the several pieces of adherend.

Rutzler[2] used resistance strain gages mounted across the adhesive bond. Thus the measurements were taken near the location of the greatest perturbation in the strain pattern, and at some distance (compared to the thickness of the bond) outward from the edge of the bond. It seems unlikely that strains measured in this way could be interpreted with confidence.

The method described here uses the specimen as a capacitor in a resonant electric circuit and measures changes in the capacitance by measuring changes in the resonant frequency of the circuit. Because of the small modulus of elasticity of the adhesive, compared to that of the adherend, the strain in the adhesive is substantially unidirectional. Thus the change in the thickness of the bond is substantially proportional to the change in the volume of the adhesive. It was hoped that the Lorenz-Lorentz equation would yield sufficiently accurate estimates of the change in the dielectric constant of the adhesive with change in volume to allow calculations of the changes in the thickness of the bond from the changes in the electrical capacitance of the specimen. This result seemed likely because it was expected that the strain would be limited to less than three per cent. As it turned out, this hope was justified only for certain adhesives.

Description of the Strain Gage

The heart of the strain gage is a resonant electric circuit arranged as an oscillator as shown in Fig. 1. The specimen is the capacitor in this circuit. A discriminator is provided, as shown, for the determination of changes in frequency. The

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* The work here reported was done at the Forest Products Laboratory, Forest Service, U. S. Department of Agriculture, as part of research sponsored by the Department of the Army under Army Project 599-01-004, ORD Proj. TB2-0001.

[1] Throughout this report the word adherend refers to the steel buttons or portions of cylinders that are glued together with various adhesives.

[2] John E. Rutzler, Jr., "Effects of Stress on Mechanical and Electrical Properties of Metals Bonded by Means of Adhesives," Case Institute of Technology, Cleveland, Ohio (1954).

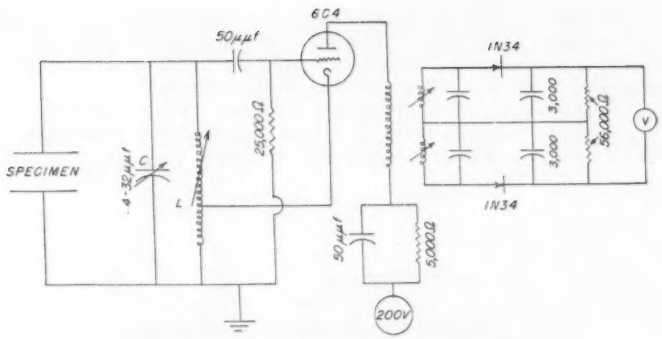

Fig. 1.—Wiring Diagram of the Strain Gage. Capacitances in $\mu\mu f$; Resistances in Ohms.

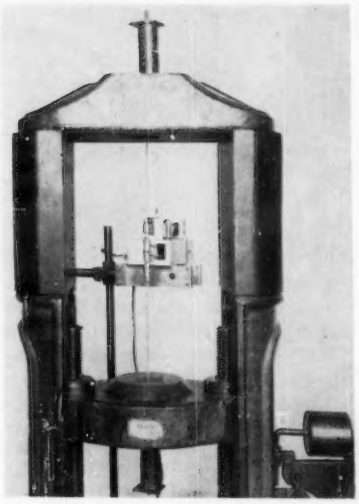

Fig. 2.—Strain Gage Connected to Test Specimen.

instrument is shown in Fig. 2 set up for a test. The load is applied to the specimen by aircraft cables and fittings as shown.

Later tests were made using a modification of the circuit shown in Fig. 1. A limiting amplifier was incorporated between the output of the oscillator and the discriminator, so that the output voltage of the discriminator would be nearly independent of variations in the output voltage of the oscillator. Four separate oscillator units having different capacitance ranges were constructed. One such unit is shown in Figs. 10 and 11.

The circuit shown in Fig. 1, and as later modified, tends to oscillate at a resonant frequency given by:[3]

$$\omega_r = \frac{1}{[LC]^{1/2}} \left[\frac{1 - R^2_L \frac{C}{L}}{1 - R^2_C \frac{C}{L}} \right]^{1/2}$$

where:

$\omega = 2\pi f$
f = frequency, cps,
L = inductance of the coil, henrys,
C = capacitance of the specimen, farads,
R_L = the resistance of the coil, ohms, and
R_C = the dielectric loss of the capacitor, ohms.

The resistance of the coil is so small that the term containing it may be neglected, and this equation becomes:

$$\omega_r = \frac{1}{[LC]^{1/2}} \times \frac{1}{\left[1 - R^2_C \frac{C}{L}\right]^{1/2}} \quad \ldots\ldots (1)$$

The resistance to the flow of current through the resonant circuit while it is oscillating at its resonant frequency is:

$$R' = \frac{R_L R_C C + L}{R_L C + R_C C} \quad \ldots\ldots (2)$$

The voltage across the discriminator was measured by means of a galvanometer connected in series with a resistance. The galvanometer read 0.00046 microamp per mm on a scale 50 cm long. The resistance could be varied in steps, from 40 to 0.15 megohm with the value of each step approximately half the value of the preceding step. Thus, a large range of potentials could be measured to about the same percentage of accuracy.

[3] See a text on radio circuits, such as "Principles of Radio Communication," by J. H. Morecroft, John Wiley & Sons, Inc., New York, (1921).

Description of Specimen

The specimen, as shown in Fig. 2, consists of two cylindrical buttons $\frac{1}{2}$ in. in diameter and $\frac{7}{8}$ in. long bonded together at their ends by the adhesive to be tested. The buttons are drilled and tapped at their unbonded ends for attachment of the aircraft fittings and drilled radially for the electrical attachment of the instrument.

These specimens were bonded in a special jig of two iron frames hinged together as shown in Fig. 3. The ends of the two halves of the specimen to be bonded are ground flat and cleaned. The lower half of the specimen is rigidly bolted to the lower frame. The upper half of the specimen is placed upon the lower half and lined up with it. The upper frame is lowered to rest on the specimen through crossed knife edges. Plaster of Paris is cast into the upper frame so that it grips the upper half of the specimen without disturbing its position. After the plaster is hardened, a number of measurements of the distance between the two points shown in Fig. 3 are taken by means of a micrometer reading to 0.0001 in. The frames are then separated (the hinges holding them in relative position to each other) and glue is applied to the exposed end surfaces of the buttons. The upper frame is then carefully lowered to permit contact, and a suitable weight placed at the outer end of the upper arm so that the total pressure at the glue line conforms to that recommended for each adhesive. The glue is then cured in accordance with a time-temperature cycle suitable for the adhesive by previously determined control of a resistance heating coil (not shown in the figures) that surrounds the specimen.

After the glue is cured, measurements of the distance between the measuring points are again taken, and the glue line thickness is calculated from the known measurements of the apparatus. This procedure results in a bond of uniform thickness, which is known to a reasonable degree of accuracy. Be-

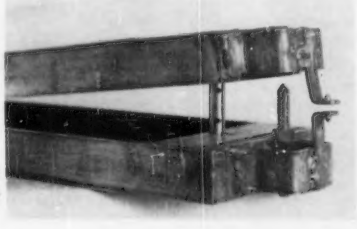

Fig. 3.—Detail of Jig Used in Bonding Specimens.

cause of the careful control of pressure, curing time, and temperature, the thickness of the adhesive bond corresponds closely to that obtained in general usage of the adhesive, and the thickness is closely reproducible between specimens.

The specimen acts as a capacitor in the oscillating circuit of the strain gage. The major part of its electrical capacitance is given in terms of the area and thickness of the adhesive bond by:

$$C = 0.0885 \frac{KA}{a} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where:

C = capacitance, $\mu\mu f$,
K = dielectric constant of the adhesive (unity for air),
A = area of the adhesive bond, sq cm, and
a = thickness of the adhesive bond, cm.

The remaining part of the capacitance is due to two stray electric fields that do not pass through the adhesive bond. The lines of force of one of the fields connect the two halves of the specimen passing around the edge of the adhesive bond; the lines of force of the other field originate on the surface of the specimen and extend infinitely into space.

The capacitance of the first field is given by:[4]

$$C_s = 0.0875P \left(\log \frac{8P}{a} + Z - 1.305 \right) \quad \ldots\ldots\ldots (4)$$

where:

$$Z = \left(1 + \frac{b}{a}\right) \log \left(1 + \frac{b}{a}\right) - \frac{b}{a} \log \frac{b}{a},$$

$P = \pi d$,
b = length of one of the buttons, and
d = diameter of the buttons.

The expression for Z may be put in the form:

$$Z = \log \frac{b}{a} + \log \left(1 + \frac{a}{b}\right) + \frac{b}{a} \log \left(1 + \frac{a}{b}\right)$$

The value of a/b is very small compared to unity, so that:

$$Z = \log \frac{b}{a} + \frac{a}{b} + 1 \qquad \text{approximately}$$

Substituting the dimensions of the specimen in this formula. and in Eq. 4,

$$C_s = 2.07 \ \mu\mu f$$

The capacitance of the second field may be estimated by the formula:[5]

$$C_g = 0.449d \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

or

$$G_g = 0.22 \ \mu\mu f \text{ for the specimen.}$$

The total stray field for the specimen amounts to the sum of these two or:

$$C_s = 2.29 \ \mu\mu f$$

Analysis of the Strain Gage

The specimen is also a part of the strain gage and changes in the electrical properties of the adhesive during test will be reflected in the readings of the gage. Such changes may occur because of changes in the density of the adhesive. During a test, the lateral displacement of the adhesive is restrained by the metallic buttons except very locally at the edge of the bond. Therefore, the density of the bond is substantially inversely proportional to its thickness.

The dielectric loss of the adhesive appears in Eqs 1 and 2 as resistance R_C. It varies with density approximately according to the equation (Appendix I):

$$\tan \delta = \frac{g\rho}{h\rho + 1} \quad \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

where:

δ = the loss angle,
ρ = the density, and
g and h are constants of the adhesive.

Thus, the loss tangent may vary at most only directly with the density.

The loss tangent and the resistance R_C of Eqs 1 and 2 are related by:

$$\tan \delta = \omega R_C C \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

and if ω is taken equal to $1/[LC]^{1/2}$ or very near to the resonant frequency, the loss tangent becomes:

$$\tan \delta = R_C \left[\frac{C}{L}\right]^{1/2}$$

and Eq 1 becomes:

$$\omega_r = \frac{1}{[LC]^{1/2}} \frac{1}{[1 - \tan^2 \delta]^{1/2}} \quad \ldots\ldots\ldots\ldots (8)$$

If the square of the loss tangent is small compared to unity, it, and its change due to density, may be neglected in Eq 8.[5]

The voltage across the discriminator varies directly with the resistance R', as given by Eq 2, as well as with the frequency. Equation 7 combined with Eq 2 at the approximate resonant frequency

$$\omega_r = \frac{1}{[LC]^{1/2}}$$

yields:

$$R' = \frac{\omega_r L R_L \tan \delta + \omega_r^2 L^2}{R_L + \omega_r L \tan \delta} \quad \ldots\ldots\ldots\ldots (9)$$

During a test, the value of ω_r changes about 1 per cent, and the value of tan δ not more than about 2 per cent in the opposite direction. Thus, the value of R' remains substantially constant during a test, and the changes in the voltage across the discriminator reflect only the changes in frequency.

It follows from these considerations that the effect on the strain gage of the changes in the loss tangent due to changes of the density of the adhesive during test may be neglected if the square of the loss tangent may be neglected in comparison with unity.

If this approximation can be made, Eq 1 becomes:

$$\omega_r = \frac{1}{[LC]^{1/2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (10)$$

The change in dielectric constant with density does have a measurable effect on the strain gage, and a correction has to be made for it. An approximation of the relation between the dielectric constant and the density is given by the Lorenz-Lorentz equation:[6]

$$\frac{K - 1}{K + 2} \frac{1}{\rho} = \beta \quad \ldots\ldots\ldots\ldots\ldots\ldots (11)$$

where:

K = the dielectric constant,
ρ = the density, and
β = a constant for any one material.

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[4] Tentative Methods of Test for A-C Capacitance, Dielectric Constant and Loss Characteristics of Electrical Insulating Materials, (D 150–54 T), 1955 Book of ASTM Standards, Part 6, p. 500.

[5] If it is assumed that the loss tangent does not change with density or frequency over the range of the test, and the value of R from Eq. 7 is used in the equations of the circuit, the resonant frequency is found to be: $\omega_r = 1/[LC]^{1/2}$.

[6] See a standard text such as "Principles of Elasticity," by Leigh Page and Norman Ilsley Adams, Jr., Chap. 2, D. Van Nostrand Co., Inc., New York (1931), or "Theoretical Physics," by Georg Joos, Chap. 25, Hafner Publishing Co., New York (1934).

Let the subscript o denote the unstrained condition and subscript a the strained condition of the adhesive bond. Then:

$$\frac{K_a - 1}{K_a + 2} \times \frac{1}{\rho_a} = \frac{K_o - 1}{K_o + 2} \times \frac{1}{\rho_o}$$

and because the density of the adhesive is inversely proportional to the thickness of the bond:

$$\frac{K_a - 1}{K_a + 2} = \frac{K_o - 1}{K_o + 2} \times \frac{a_o}{a}$$

and

$$K_a = \frac{(K_o + 2)a + 2(K_o - 1)a_o}{(K_o + 2)a - (K_o - 1)a_o}$$

Using this value of the dielectric constant, Eq 3 becomes:

$$C = 0.0885 \frac{A}{a} \frac{(K_o + 2)a + 2(K_o - 1)a_o}{(K_o + 2)a - (K_o - 1)a_o} \quad \ldots\ldots (12)$$

Now by combining the differential of Eq 10 with Eq 10:

$$\frac{d\omega_r}{\omega_r} = -\frac{dC}{2C} \quad \ldots\ldots [13]$$

Using Eq 12,

$$\frac{d\omega_r}{\omega_r} = \frac{(K_o + 2)^2 + 4(K_o + 2)(K_o - 1)\frac{a_o}{a} - 2(K_o - 1)^2\left(\frac{a_o}{a}\right)^2}{(K_o + 2)^2 + (K_o + 2)(K_o - 1)\frac{a_o}{a} - 2(K_o - 1)^2\left(\frac{a_o}{a}\right)^2} \frac{da}{2a} \quad (14)$$

and if a exceeds a_o by only a small amount, a_o/a may be placed equal to unity and:

$$\frac{d\omega_r}{\omega_r} = \frac{K_o^2 + 4K_o - 2}{3K_o} \frac{da}{2a} \quad \ldots\ldots (15)$$

This equation shows the relation between the resonant frequency of the strain gage and the strain in the adhesive bond of the specimen, provided the Lorenz-Lorentz equation applies to the adhesive tested.

Calibration of Strain Gage

Since the multiplying factor of the discriminator was unknown, a calibration of the strain gage was necessary. The calibration was made by connecting the strain gage to a calibrated capacitor, rather than to the specimen. Readings of the capacitor were plotted against readings of the galvanometer connected in series with the various resistances as previously described. One of the capacitors used consisted of two plates that were displaced known distances. This capacitor is described in Appendix II.

It was found that the strain gage exhibited an internal capacitance. This capacitance was measured in two steps. First, a known capacitance was connected in place of the specimen, and the inductance of the gage was adjusted until the galvanometer read zero. From the design of the discriminator, the frequency of the resonant circuit was then 4.8 Mc. Second, the setting of the gage was not disturbed, but the calibrated condenser was disconnected from the gage. The unshielded circuit of a Q meter was brought near the leads of the gage. The frequency of the Q meter was adjusted until a beat between this frequency and that of the gage was found. This beat was detected by the action of the voltmeter associated with the Q meter. Thus, the frequency of the gage with nothing connected between its leads was determined. From these two measurements the internal capacitance associated with the gage was computed.

The data obtained in the calibration relates the galvanometer readings to changes in the capacitance of the calibrated capacitor and thus to the changes in frequency by means of Eq 13 and, finally, to the strain in the specimen by means of Eq 15.

The capacitance C in Eq 13 includes the internal capacitance of the strain gage as well as the capacitance of the calibrated capacitor, thus:

$$C = C_c + C_i$$

where:

C_c = capacitance of the calibrated capacitor,
C_i = internal capacitance of the strain gage.

The integration (with proper limits) of Eq 13 leads to

$$\log \frac{\omega_r}{\omega_o} = \frac{1}{2} \log \frac{C_o + C_i}{C_c + C_i} \quad \ldots\ldots (16)$$

where the subscript o relates to the condition of zero galvanometer reading.

The calibration curve is obtained by plotting the galvanometer readings against $\log (C_o + C_i)/(C_c + C_i)$ or for small changes against $(C_o - C_c)/(C_o + C_i)$. Equations 15 and 16 show that:

$$\log \frac{C_o + C_i}{C_c + C_i} = 2 \log \frac{\omega_r}{\omega_o} = \frac{K_o^2 + 4K_o - 2}{3K_o} \log \frac{a}{a_o} \quad \ldots (17)$$

and, therefore, this curve can be used for the determination of the strain in an adhesive bond if the dielectric constant of the unstrained bond is known. If the strains are very large, Eq 14 should be used instead of Eq 15. The thickness of the bond need not be known.

Two Corrections Associated with Use of Strain Gage

Equation 15 is correct only if the capacitance involved is that capacitance associated only with the adhesive bond. Because this is never true, a correction of Eqs 15 and 17 is required. Also, another correction is required because of the change in R' of Eq 2 from specimen to specimen.

The strain gage and a calibrated capacitor are used to measure the electrical capacitance of the specimen. The specimen is connected to the gage and placed in a position remote from objects that may affect the measurement. The inductance in the gage is adjusted until the galvanometer reads zero. The specimen is then replaced by the calibrated capacitor which is adjusted until the galvanometer again reads zero. The reading of the capacitor then yields the capacitance of the specimen. This capacitance includes the capacitance of the stray field of the specimen previously described. This measured capacitance will be designated by the symbol C_{om}.

The specimen is then mounted in the testing machine as shown in Fig. 2 and its capacitance measured again. This capacitance includes that of the aircraft fittings and cables and that due to the proximity of the testing machine. This capacitance will be designated by the symbol C_{im}.

It is evident that the strains obtained from Eq 17 will be too small and should be multiplied by the factor:

$$\frac{C_{im} + C_i}{C_{om} - C_i} \quad \ldots\ldots (18)$$

A second correction is also required.[7] It has to do with the change in discriminator voltage when a specimen is connected to the gage in place of the calibrated capacitor used in the calibration of the gage. The loss tangent of the calibrated capacitor is very small, but the loss tangent of a specimen may be considerably larger. Thus, when a specimen is substituted for the calibrated capacitor, the resistance of the gage R' is changed according to Eq 9 and the voltage across the discriminator is changed accordingly.

The calibration curve of the gage exhibits a maximum and a minimum point beyond its useful straight-line portion.

[7] The inclusion of the limiting amplifier in the circuit greatly reduced the amount of this correction.

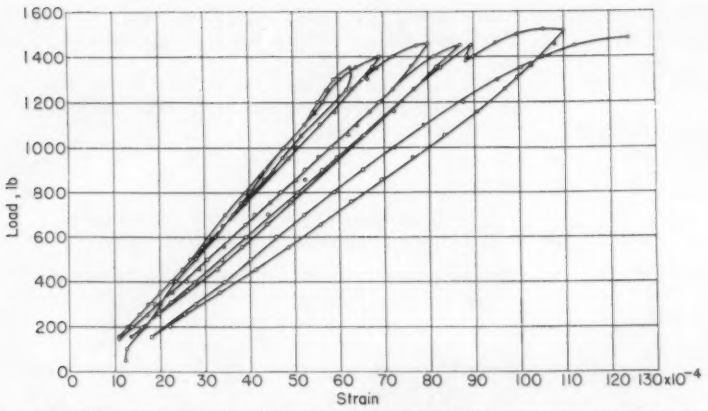

Fig. 4.—Load-Strain Curve of an Epoxy Resin Modified with Dimethylaminoethyl Alcohol and Milled Glass Fibers.

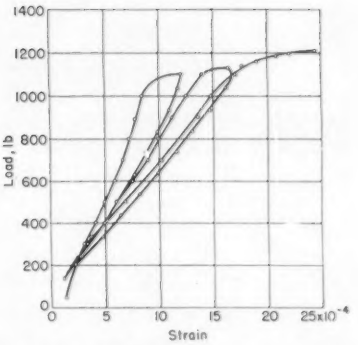

Fig. 6.—Load-Strain Curve of an Epoxy Resin Modified with Dimethylaminoethyl Alcohol and Polysulfide Elastometer.

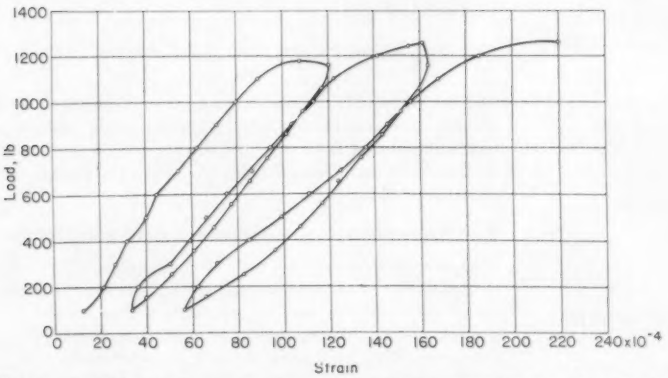

Fig. 5.—Load-Strain Curve of a Commercially Formulated Methacrylate Resin.

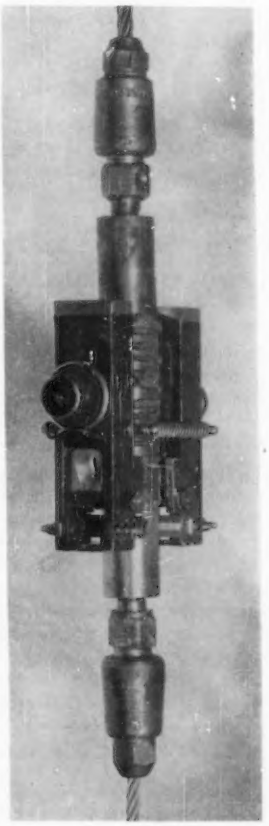

Fig. 7.—Tuckerman Strain Gages Mounted on Specimen Having 14 Bonded Joints.

When a specimen is connected to the strain gage, the value of one of these points is again determined. The ratio of the value obtained in the calibration to this value is the required correction factor. A variable capacitor placed in parallel with the specimen as shown in Fig. 1 is used for the convenient determination of the value of one of these points.

Examples of Stress-Strain Curves

Figures 4, 5, and 6 are examples of the load-strain curves obtained from three different adhesive bonds about 0.0015 in. thick tested in the apparatus shown in Fig. 2. The testing machine was equipped with a reversible motor so that the load on the specimen could be decreased at the same rate as it was increased. The aircraft cables were very elastic, compared to the specimens. Therefore, a constant rate of movement of the head of the testing machine subjected the specimens to a constant rate of loading. The load was applied and removed successively, as the curves indicate.

It is evident from the smoothness of these curves that very fine measurements of strain are obtained, provided that the Lorenz-Lorentz equation is adequate for the computation of the change in the dielectric constant of the adhesives during test. The shapes of the curves yield interesting information concerning the elastic and plastic properties of the adhesive bonds.

Comparison of the Strain Gage with a Mechanical-Optical Gage

A rough check of the strain gage was obtained by comparing the modulus of elasticity of an adhesive bond obtained by its use with the modulus of similar bonds obtained by means of a Tuckerman strain gage. The Tuckerman gage is not sufficiently sensitive to measure the strain in a single bond, so a specimen having 14 bonds was made. Figure 7 shows this specimen with a pair of Tuckerman gages mounted on it. The specimen was made in the jig illustrated in Fig. 3 so that the sum of the thicknesses of the 14 bonds was known. The elongation of the steel parts of the specimen was computed using a modulus of elasticity of 30,000,000 psi. This elongation was subtracted from the measured elongation to obtain an estimate of the elongation of the 14 adhesive bonds. In this manner, the modulus of elasticity of the adhesive was found to be 895,000 psi.

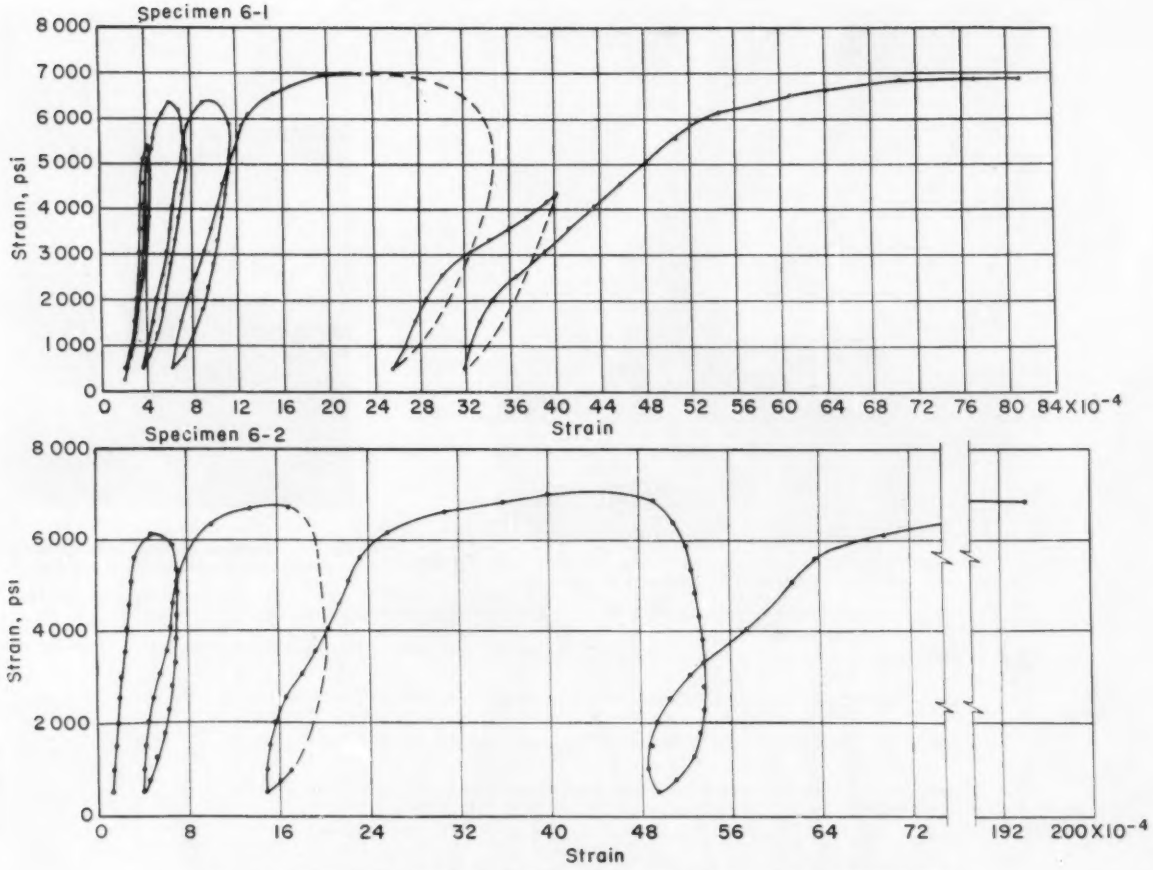

Fig. 8.—Stress-Strain Curves of Duplicate Specimens. Upper Curve, Adhesive Film 0.0036 in. Thick; Lower Curve, Adhesive Film 0.0040 in. Thick.

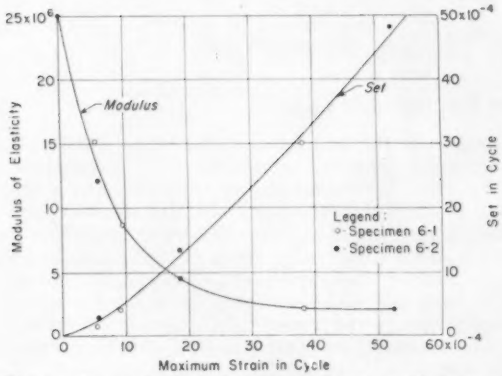

Fig. 9.—Curves Showing Relation of Strain to Modulus of Elasticity and Set for Duplicate Specimens.

A specimen containing a single bond was made with the same adhesive cured in the same way. This specimen was tested as illustrated in Fig. 2. The modulus of elasticity of the adhesive was found to be 3,010,000 psi. This specimen was also tested by means of a strain gage that employs an entirely different electric circuit, as described in Appendix III. The modulus of elasticity was found to be 3,060,000 psi.

The Tuckerman gage method is subject to the errors noted in the introduction, and there is some question concerning the validity of the Lorenz-Lorentz equation when applied to the particular adhesive used.

Reproducibility of Experimental Results

Two duplicate specimens were made, using a phenol-vinyl type adhesive, Redux K6, manufactured by the Ciba Co., Inc. The time-temperature curves of the curing periods of these specimens were identical. It was previously found that specimens having different time-temperature curves during curing were not identical.

The stress-strain curves of these two specimens are given in Fig. 8. The specimen represented by the upper curve was not broken. One of the cable fasteners slipped during the test. The other specimen was broken.

It can be seen from these two curves that both specimens exhibited substantially the same modulus of elasticity, proportional limit stress, and maximum stress. The values obtained from these tests are:

Modulus of elasticity, psi	25,000,000
Strength, psi	7,200
Strain to failure:	
Total	0.01964
Elastic	0.00022
Plastic	0.01942

The curves of Fig. 8 show that after each stress cycle, the modulus of elasticity is reduced, and some set is obtained. In Fig. 9, the set at the end of a cycle is plotted against the maximum strain in the cycle, and the modulus of elasticity of a cycle is plotted against the maximum strain of the previous

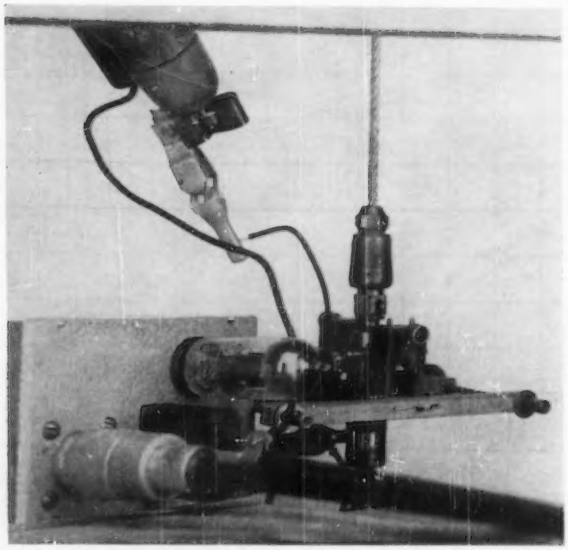

Fig. 10.—View of Test Specimen Showing Tuckerman Gages, Vacuum Tube Voltmeter Connections, and Oscillator Unit of Capacitance Strain Gage.

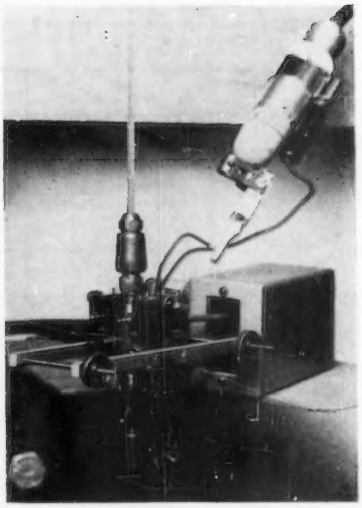

Fig. 11.—Another View of Test Specimen and Adjacent Apparatus Shown in Fig. 10.

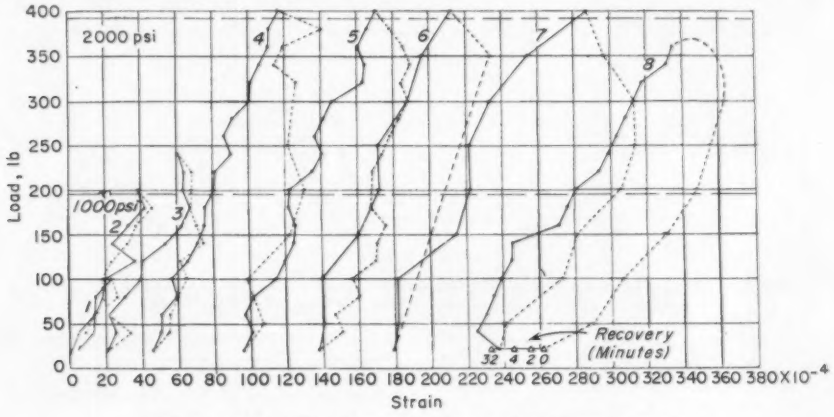

Fig. 12.—Load-Strain Curves Obtained with Tuckerman Gages.

cycle. In the figure, the points designated by open circles apply to one specimen and closed circles apply to the other. It is evident that the two specimens reacted to the test almost identically.

Behavior of Two Adhesives Containing Rubber

Two adhesives containing rubber were tested. They were Scotch Weld AF6, made by the Minnesota Mining and Manufacturing Co., and Metlbond M3C, made by the Narmco Resins and Coatings Co. These adhesives are an acrylonitrile-butadiene rubber and phenol type, and a neoprene-phenolic type, respectively.

These adhesives exhibited a negative modulus of elasticity when tested by the capacitance method described in this report. A negative modulus is, of course, impossible. To check the possibility that these results might be due to inadvertent bending of the specimen, the test was repeated in compression. Again a negative modulus of elasticity was obtained. The conclusion was that this effect was due to the inadequacy of the Lorenz-Lorentz equation. Similar effects were found by Scott[8] for some rubber-sulfur compounds.

The Scotch Weld specimen was again set up for a tension test. Tuckerman strain gages were also mounted on it as shown in Figs. 10 and 11. The Tuckerman gages were insulated from the specimen by means of plastic insulating tape 0.007 in. thick. These figures also show a part of the capacitance strain gage with leads connected to the specimen, and the probe and ground connection of a vacuum-tube voltmeter used for measuring the alternating-current voltage across the specimen.

A test was made similar to those previously reported. The load was increased and decreased through eight cycles, and simultaneous readings were made of the Tuckerman gages, the capacitance strain gage, and the voltage across the specimen. The Tuckerman gage readings were reduced to strain readings by the method previously described, assuming the modulus of elasticity of the steel buttons of the test specimen to be 30,000,000 psi. Figure 12 shows the load-strain curves obtained in this way. It may be noted that these curves indicate a modulus of elasticity of about 260,000 psi that is nearly independent of the plastic strain. Figure 13 shows the load-strain curves simultaneously obtained by means of the

[8] Arnold H. Scott, "Effect of Pressure on Dielectric Constant, Power Factor, and Conductivity of Rubber-Sulfur Compounds," Research Paper RP806, *Journal of Research*, National Bureau of Standards, Vol. 15, No. 9, July, 1935, pp. 13–34.

capacitance strain gage. The apparent negative modulus of elasticity obtained at the start of the test is very evident. Figure 14 shows curves obtained by plotting the voltage across the specimen against the load on the specimen. They indicate that the voltage varies substantially with the stress or the elastic strain, rather than with the total strain.

Discussion and Conclusion

It is evident that the strain gage developed is extremely sensitive and may be satisfactory for use with adhesives that satisfy the Lorenz-Lorentz equation. The work of Horton and Rogers[9] shows that it can be applied to polystyrene if a constant correction factor is employed.

They found that for polystyrene and Lucite:

$$\frac{\Delta K}{K} = -\alpha \frac{\Delta a}{a} \quad \ldots\ldots\ldots\ldots\ldots\ldots (19)$$

where:

K = dielectric constant,
a = thickness of adhesive bond, and
α = a constant for the material.

Equation 19 is consistent with the Lorenz-Lorentz equation if:

$$\alpha = \frac{(K+2)(K-1)}{3K} \quad \ldots\ldots\ldots\ldots\ldots\ldots (20)$$

Data of Horton and Rogers indicated a value of 2.56 for K for polystyrene. Substitution of this value in Eq 20 yields a value of 0.926 for α. Horton and Rogers report experimental values of 0.708, 0.725, and 0.818, or an average value of 0.750. Thus a proper correction factor may be obtained.

On the other hand, the adhesives containing certain rubber-like materials did not satisfy the Lorenz-Lorentz equation. In fact, they deviated greatly from it. For these adhesives, the polarization resulting from an applied field is increased greatly by strain. The reason for this increase is suggested by Braybon.[10]

The method of strain measurement described should be satisfactory for any adhesive if detailed information on the effect of strain on the dielectric constant of the adhesive is available. The method may be adequate for some adhesives without such information, provided it is possible to substantiate the results by some other method of strain measurement. It does not appear that a mechanical gage of adequate sensitivity is possible, but it is possible that an adequately sensitive strain gage based on changes in the magnetic reluctance of the glue line can be designed. Such a gage would not be affected by dielectric properties of the adhesive.

[9] C. W. Horton, and R. G. Rogers, "Dielectric Constant—Strain Coefficient of Polystyrene and Lucite at 3.2 cm.," *Journal of Polymer Science*, Vol. XVII, June, 1955, pp. 191–205.

[10] J. E. H. Braybon, "The Mechanism of Stress Birefringence in Amorphous Solids," *Proc.*, Phys. Soc. of London B66, (1953), pp. 617–621. See particularly Eq. A5.

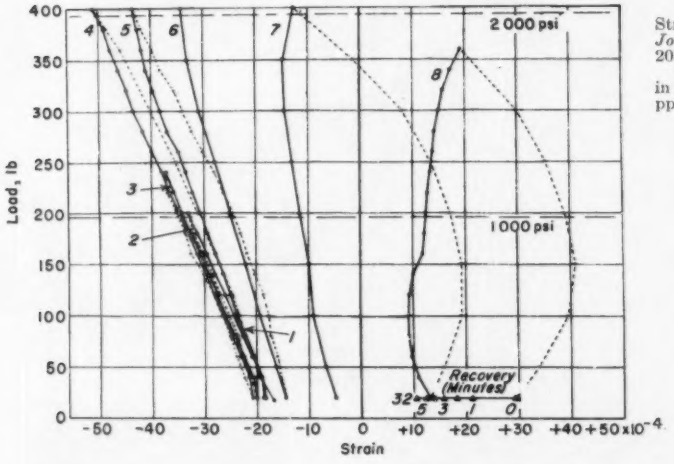

Fig. 13.—Load-Strain Curves Obtained with Capacitance Gage.

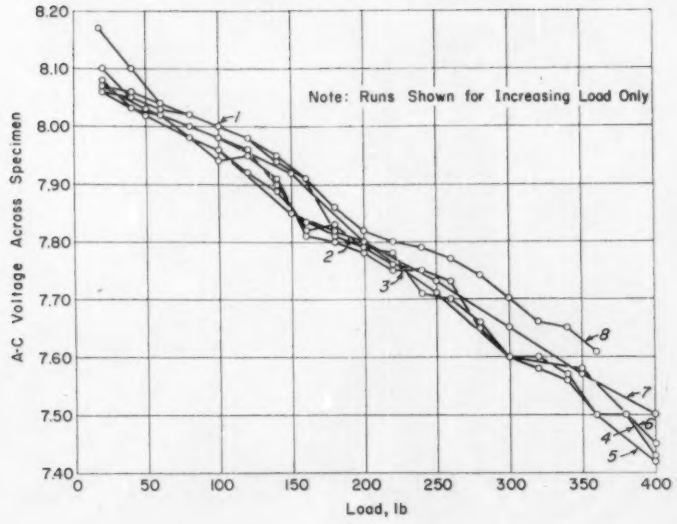

Fig. 14.—Voltage-Load Curves.

APPENDIX I

VARIATION OF DIELECTRIC LOSS WITH DENSITY

Quoting from information supplied by Andrew Gemant of the Detroit Edison Co.:

"The dielectric losses in commercial dielectrics are mostly not easily reproduced by simple equations, chiefly because the losses are caused by a superposition of several mechanisms, possessing different time constants. In the frequency range of your apparatus, however, the losses are chiefly due to rotation of dipoles, as treated by Debye. Taking the simple case of only one time constant, the dielectric loss angle is approximately

$$\tan \delta = \frac{(\epsilon_o - \epsilon_\infty)\omega t}{\epsilon_o + \epsilon_\infty(\omega t)^2}$$

where,

ϵ_o = dielectric constant at very low frequencies,

ϵ_∞ = dielectric constant at very high frequencies,

ω = 2π times frequency of a-c voltage, and

t = relaxation time of dipoles.

With $\epsilon = 1 + 4\pi\alpha$, approximately, where α = polarizability, and taking the latter proportional to the density ρ, it is possible to arrive at a formula such as:

$$\tan \delta = \frac{a\rho}{b\rho + 1}$$

with a and b = constants, to be determined experimentally. Because of the many approximations involved, the value of the formula for making your correction is limited."

APPENDIX II

DESCRIPTION OF A VARIABLE CAPACITOR

It was desirable to make a calibration of the strain gage under conditions similar to those of the use of the gage. Figure 15 shows the gage attached to the apparatus devised. It is connected to two metallic tips mounted on rods made of compreg (compressed resin-impregnated wood). These rods are supported by a 2- by 2-in. steel beam by means of knife-edged stirrups as shown. The lower metallic tip is spherically hollow ground on its upper surface. A segment of a metallic sphere rests on the ground surface with its flat surface upward. A horizontal iron wire connects the base of the upper rod to the framework supporting the lower rod to mechanically stabilize the apparatus.

Before the apparatus was used in the calibration of the strain gage, it was placed in a testing machine and load applied to the center of the steel beam. A mechanical-optical strain gage was mounted on the metallic tips to measure their relative movement. A load-displacement curve was obtained. The displacements were sufficiently great so that the mechanical-optical strain gage could be easily read. The curve obtained was a straight line that could be accurately extrapolated to very small displacements.

For calibration of the strain gage, means (not shown in Fig. 15) were provided for applying variable dead load to the center of the beam. As the beam deflected under this load, the upper metallic tip was brought into contact with the flat surface of the segment of the sphere supported by the lower tip. The load was increased until the two surfaces (that of the sphere segment and that of the upper tip) were in parallel contact. The load was then decreased until the strain gage indicated a break of contact. Known spacings between these surfaces could then be simply calculated from the value of the loads applied to the beam. The electrical capacitance of the condenser formed by the two tips could be calculated from the known spacings by means of the formulas given in the body of the report.

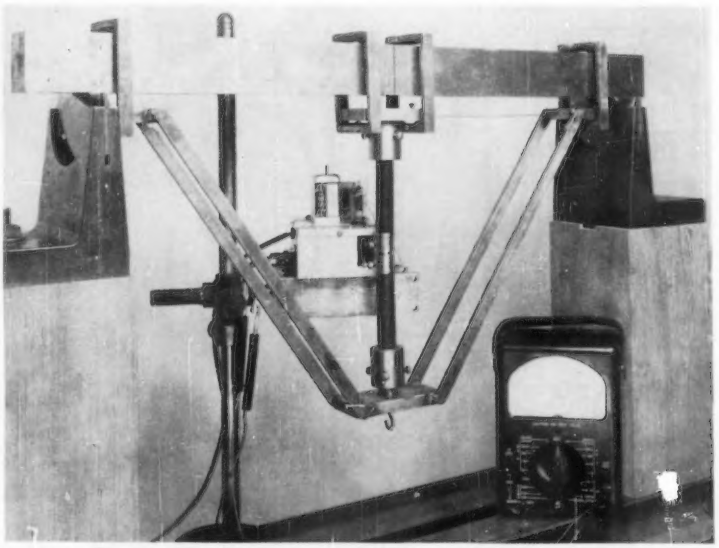

Fig. 15.—Variable Condenser that Does not Require Calibration.

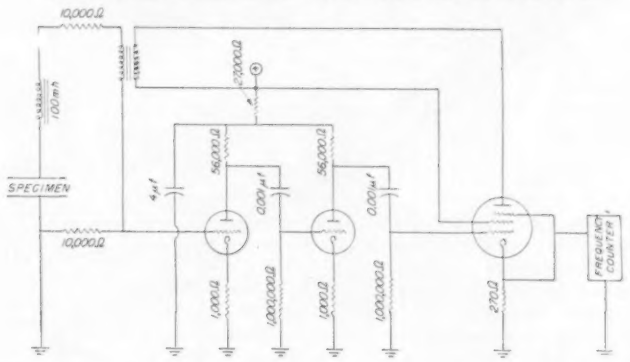

Fig. 16.—Wiring Diagram of a Strain Gage Capable of Measuring Strains in Specimens Having Large Dielectric Losses. Capacitances in μμf, Resistances in Ohms, and Inductance in mh.

APPENDIX III

A STRAIN GAGE FOR SPECIMENS HAVING LARGE DIELECTRIC LOSSES

The capacitance strain gages discussed in the body of this report measure strains in terms of a frequency change. The frequency is influenced to some extent by the dielectric loss of the capacitor, as shown in Eq. 1. It was considered desirable to construct a capacitance-type strain gage using an oscillator circuit in which the frequency is independent of dielectric loss, in order to determine whether that factor was the primary cause of the difficulties encountered in testing certain adhesives.

The electrical circuit for such a gage is shown in Fig. 16. This gage operates at a frequency of about 50,000 cps, and a frequency counter was used with it rather than a discriminator.

The equation for the calibration of this gage is:

$$\log \frac{\omega_r}{\omega_o} = B \log \frac{C_o + C_i}{C_c + C_i}$$

or for C_c not greatly different from C_o

$$\frac{\omega_r - \omega_o}{\omega_o} = B \frac{C_o - C_c}{C_c + C_i}$$

Values of B and C_i are determined from the calibration curves.

It was found in the calibration that a resistance of 2000 ohms connected in series with the calibrated capacitor did not change the value of B obtained. It follows that values of strains obtained by the use of this gage will be independent of the dielectric loss of the specimen even though this loss is quite large. However, essentially the same results were obtained with this gage as with the type shown in Fig. 1 and, in particular, an apparent negative modulus of elasticity was obtained with certain adhesives using gages of either type. Further work with this type of gage was not undertaken, because of the greater sensitivity and simplicity of operation of the original gage.

The ASTM Copper-Strip Corrosion Standards*

By R. C. Mallatt, P. A. Demkovich, and W. V. Cropper

These visual Standards are prescribed for use in evaluating copper strips that have undergone the ASTM D 130 procedure for detection of sulfur corrosiveness in petroleum products.

Most petroleum products are continually in contact with metals during manufacture and in service. Corrosiveness toward metals, often caused by sulfur and its compounds, is therefore an important aspect of product quality. The action of sulfur and corrosive sulfur compounds on copper metal has become a criterion for measuring corrosiveness.

A well-known copper-strip test, method D 130,[1] has been an ASTM method since 1921 (first published as D 89) and is the most widely applicable of current standard copper-strip tests.[2–6] It is used to detect corrosiveness of aviation gasoline, automotive gasoline, farm tractor fuel, cleaners

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the authors. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* This paper was prepared upon invitation from and with approval of Research Division X, ASTM Committee D-2 on Petroleum Products and Lubricants; F. D. Tuemmler, Chairman; R. W. Altman, W. E. Campbell, H. G. Cannon, Jr., W. V. Cropper, N. J. Gothard, R. J. Harrington, B. J. Heinrich, R. T. Jones, J. B. Rather, Jr., E. L. Ruh, G. N. Soeder, and H. R. Wolf.

[1] Tentative Method of Test for Copper Corrosion by Petroleum Products (Copper Strip Test) (D 130 – 55 T), 1955 Book of ASTM Standards, Part 4, p. 339; Part 5, p. 85.

[2] Specification for Petroleum Spirits (Mineral Spirits) (D 235 – 39), 1955 Book of ASTM Standards, Part 4, p. 230; Part 5, p. 140.

[3] Tentative Specification for Heavy Petroleum Spirits (Heavy Mineral Spirits) (D 965 – 48 T), 1955 Book of ASTM Standards, Part 4, p. 232; Part 5, p. 430.

[4] Method of Test for Detection of Free Sulfur in Electrical Insulating Oils (D 989 – 51), 1955 Book of ASTM Standards, Part 5, p. 460; Part 6, p. 745.

[5] Method of Test for Effect of Grease on Copper (D 1261 – 55), 1955 Book of ASTM Standards, Part 5, p. 660.

[6] Tentative Method of Test for Corrosive Sulfur in Electrical Insulating Oils (D 1275 – 53 T), 1955 Book of ASTM Standards, Part 5, p. 707; Part 6, p. 742.

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solvent, diesel fuel, distillate fuel, and other products. In this method, which is similar in principle to all copper-strip methods, a polished copper strip is immersed in a given quantity of sample and heated at a temperature and for a time specified for the product being tested. The strip is then removed, washed, and examined visually.

The appearance of a corroded strip is not easy to describe. Before the revision of the method in 1954, such phrases as "No corrosion" or "Slightly discolored" were used to indicate the amount of tarnish or corrosion. These were obviously subject to differing interpretations. Method D 130 now requires comparing the test strip with the ASTM copper-strip corrosion standards for classification. The result of the test is reported as the number-letter designation of the standard strip that matches the test strip.

The ASTM copper-strip corrosion standards are full-color reproductions of actual test strips conforming to master standards adopted by ASTM to show the progressive corrosion of copper through various stages. They fill a long-existing need and constitute a distinct contribution to product-quality control.

Much of the work done in developing the standards was part of the program of Research Division X of ASTM Committee D-2. The proper location and degree of corrosion of each strip were determined by task groups in 1952 and 1953. Results of this work enabled the division to recommend standardization of the corrosion series as described in Table I. Solution of the problems of mass reproduction of the series was followed by ASTM approval in June, 1954. The standards became available through ASTM headquarters in December, 1954.

TABLE I.—DESCRIPTION OF CORRODED COPPER STRIPS.

ASTM Classification	Description	Indiana Copper Corrosion Standards (ICCS) Number
Freshly polished strip[a]		0
1*a*	Light orange, almost the same as a freshly polished strip	1
1*b*	Dark orange	2
2*a*	Claret red	3
2*b*	Lavender	4
2*c*	Multicolored with lavender, blue and /or silver overlaid on claret red (no green)	..
2*d*	Silvery	5
2*e*	Brassy or gold	6
3*a*	Magenta overcast on brassy strip	7
3*b*	Multicolored, with red and green showing (peacock), but no gray	8
4*a*	Transparent black, dark gray or brown with peacock green barely showing	9
4*b*	Graphite or lusterless black	10
4*c*	Glossy or jet black	11

[a] The freshly polished strip is included in the series only as an indication of the appearance of a properly polished strip before a test run; it is not possible to duplicate this appearance after a test even with a completely noncorrosive sample.

Development of Standard Series

In 1947, Bolt[7] observed that copper-strip corrosion manifests itself in a series of distinct colors. When exposed to a corrosive hydrocarbon mixture, a polished copper strip passes progressively through shades of orange, red, lavender, silver, and brassy, then becomes peacock or multicolored, and finally turns black. He prepared a series of copper strips showing the progressive changes in color by exposing freshly polished strips for increasing time intervals in solutions of elemental sulfur or sulfurized dipentene. The resulting numbered series was designated as the Indiana Copper Corrosion Standards (ICCS), and is described in Table I.

Workers in other petroleum laboratories independently devised similar standards using either air oxidation or hydrocarbon solutions of sulfur or sulfur compounds to develop the colors. Comparison of these various standards revealed an apparent anomaly in the order of the colors through which the copper surface progresses. Two kinds of multicolored strips were present in these corrosion series: (1) red with blue and gray and (2) red with green but no blue or gray. The location of the red with green strip was agreed to be between the brassy with red and the transparent black. But the red with blue and gray was more elusive; some of the series did not show it at all, and others showed it but did not agree on its location. To enable ASTM to establish corrosion standards, definitive work was necessary to clarify this apparent inconsistency.

Cathodic reduction of corrosion films was reported by Matthews and Parsons[8] in 1950. The corroded copper strip was made the cathode of an electrolytic cell with sodium hydroxide solution as the electrolyte; the anode was clean copper. A small current was applied, and the variation of potential across the electrodes with time gave a measure of the amounts of cuprous and cupric sulfides or oxides present on the copper strip.

In 1953, the present authors used similar equipment to evaluate ICCS strips 2 to 9 and multicolored red with blue strips furnished by the Esso Research and Engineering Co. The actual numerical results of Matthews and Parsons were duplicated on several strips. The comparison is shown in Fig. 1, where the strips are identified by both the ICCS and the new ASTM designations. The scatter of the data suggested that the limits of the method had been reached.

In an attempt to find a more dependable way to evaluate corroded strips, a chemical method of determining the amount of oxidized copper in the

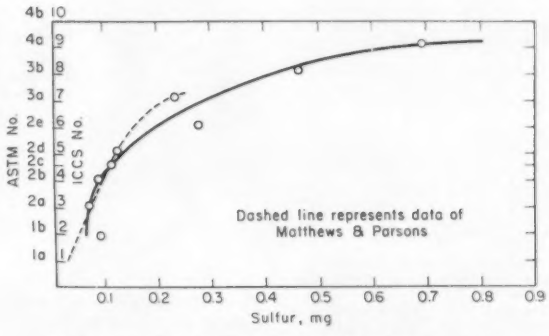

Fig. 1.—Sulfur in Films on Corroded Copper Strips.

[7] J. A. Bolt, "Copper-Strip Corrosion Tests", *Oil and Gas Journal*, Vol. 46, No. 14, p. 99 (1947).

[8] F. W. H. Matthews and D. F. Parsons, "The Copper Strip Test—A Study of Current Methods of Interpretation and an Examination of Proposed New Procedures," *Proceedings*, Am. Petroleum Inst., Ser. III, Vol. 30M, p. 24 (1950).

corrosion films was devised. Aqueous potassium cyanide was used to dissolve the corrosion film, without attacking the copper metal, and form the stable cuprocyanide complex $Cu(CN)_3^{=}$. The complex was destroyed by boiling with nitric acid; the copper was determined colorimetrically with sodium diethyldithiocarbamate.[9] The results of the assay of ICCS strips 1 to 9 and the multicolored red with blue strips are shown in Fig. 2, in which the new ASTM designations of the strips are again listed.

The data obtained by the chemical-colorimetric analysis showed much less scatter than those obtained by cathodic reduction. The more gentle slope of the line shown in Fig. 2 also gave a more reliable correlation than given by Fig. 1. But both methods show the same progression of colors with increasing corrosion of copper strips.

As a result of this work, it is now known that color progression during corrosion is rather uniform from light orange to lavender. A multicolored strip, which exhibits red, gray, and blue shadings, is observed next. Further corrosion produces a brassy appearance, not much different from the light orange first seen, followed by a reddish overcast. Another multicolored surface appears at this more advanced point; the red shading is again present, but is streaked with green and lacks the blue and gray tones. Deeper shades of gray again become evident with further corrosion.

This knowledge permitted the preparation of a corrosion series showing the correct color progression, which Research Division X recommended for standardization. Formal ASTM adoption included acceptance of three identical sets of "master standards" and authorization for reproducing them in a form suitable for large-scale distribution. The master standards were prepared by the Esso Research and Engineering Co. by a process that provides reference strips, sealed in glass tubes under vacuum, that are highly stable to light and time. Because the preparation of each strip by this process requires the attention of a highly skilled technician, a more suitable reproduction method was desired.

[9] C. A. Noll and L. D. Betz, "Determination of Copper Ion by a Modified Sodium Diethyldithiocarbamate Procedure," *Analytical Chemistry*, No. 24, p. 1894 (1952).

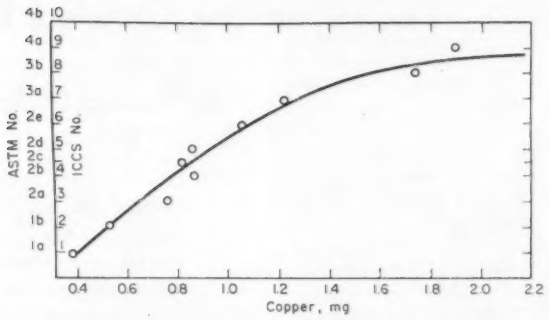

Fig. 2.—Copper in Films on Corroded Copper Strips.

Reproduction of Standard Strips

Mass reproduction of the standards presented a formidable problem because of the large number of exact duplicates required.

The simplest approach was for each laboratory to prepare its own standards by immersing polished strips in corrosive naphtha under specified conditions. This method proved too time-consuming and expensive and produced strips not stable enough to be useful. Furthermore, colors of some of the strips could not be duplicated in different laboratories, even though the instructions were explicitly followed.

Satisfactory reproductions of the ICCS series had been made by air-brushing strips of copper, aluminum, and brass with lacquer solutions of yellow, red, blue, violet, and black Azosol dyes. The prepared sets of strips were mounted in plastic cases. The dyes used showed only barely perceptible fading after two months of exposure to daylight, but this technique was too expensive for the large number of sets that would be required by ASTM.

Color photographs of the sets of strips were also considered, but available dyes were reported insufficiently stable to light. Photographers would give no assurance that identical copies could be prepared in large numbers.

A lithographic process showing the sets of colored strips printed on paper would have been convenient. This method, however, produced colors that were unstable and unrealistic; the surface appearance of the actual strips could not be accurately represented. For these reasons, lithography on paper was abandoned.

Consultations with the Lithographic Technical Foundation indicated that a lithographic process on metal, preferably aluminum, might prove suitable. A complete set of strips corresponding to the ASTM master standards was prepared and photographed to obtain color-separation negatives. Rotary-press plates were made from the negatives for white, gold, red, black, blue, and copper inks. Flat sheets of aluminum large enough to accommodate 20 plaques, each bearing the complete series of strips, were grained and degreased. A prime coat of lacquer was baked on. After each color was applied, it was baked to assure thorough drying before printing a subsequent color. After all colors were applied, a clear vinyl coat was applied for protection. The finished sheets were then cut and trimmed before inspection by a subcommittee appointed by Research Division X. All plaques were inspected individually and imperfect ones were rejected. Of the 10,500 plaques made, about 1700 were judged to be acceptable and were mounted in clear plastic cases on which appropriate text was printed by the silk-screen process. To protect the standards from light, they were enclosed in opaque plastic bags.

Nearly 1000 standards have been sold and are in use throughout the industry.

Acknowledgment

The work described was carried out by many individuals and firms. The authors gratefully recognize the contributions of Esso Research and Engineering Co., Central Scientific Co., Sinclair Refining Co., Shell Development Co., Casper's Tin Plate Co., and The Chicago Litho Plate Graining Co.

Testing in the Guided Missile Industry*

By Rebecca H. Sparling

Factors that make the industry unique—the reasons why requirements for materials and parts are different, and often stricter, than those for other users—test methods employed—suggested areas for future ASTM work.

FOR SECURITY reasons, this paper is limited to a discussion of test methods and test philosophy used in the design and manufacture of guided missiles. Systems tests of complete missiles or major assemblies and flight tests are not included.

This paper deals with the importance of testing during manufacture of missiles; the types of tests used; and the areas where standardization is needed. The views expressed are not only those of the author but also include comments from 18 other leading missile producers.

Importance of Testing

Tests are performed in the guided missile industry for the same purpose as in any other field: namely, to assure that materials and components meet a predetermined level of quality. In addition, there are certain factors which make testing more important than in commercial practice:

1. The importance of the product to national defense. A company in commercial work may, if its test program is inadequate, lose money and lose customers. But if the tests in a missile plant do not provide sufficient information, a life, or a battle, or a war may be lost. Any ordnance or defense weapon has this terrible responsibility.

2. Missiles are comparatively new products. The wealth of experience which results from 50 years of designing and building automobiles, or 100 years of railroad operation, cannot be simulated even by the giant electronic brains. Missile engineers, lacking the benefit of years of service, may be overconservative in some test requirements. Later on, as the backlog of field experience grows, no doubt some present specifications will be relaxed.

3. Missiles, by their nature, are "one-shot" vehicles. It is very hard to determine the exact cause of failure in a mechanism which is moving at supersonic speeds, for only a second or so, and which explodes so thoroughly that there is no "corpus delicti." Piloted aircraft benefit greatly from the observations of trained crews during the test flights. Missiles, whose systems and performance may be much more complicated than a bomber or fighter plane, must do without such help.

4. Because of the guided missile's importance to national defense, reliability is a prime objective. A reliable missile must have reliability in design—marginal design may permit extra performance on many flights but might cause failure at some crucial moment. Missiles must be built of reliable materials and components, which will remain operable after long storage, or in the humid tropics, or in the frigid arctic. Yet performance cannot be sacrificed to reliability. The missile design engineer constantly strives to achieve reliability without compromising performance. For this reason, testing of materials, components, and parts is essential.

Philosophy of Testing

A questionnaire on testing in the guided missile industry—why, when, what—was sent to 22 companies in this field. Twenty replied, one of which is not now engaged in missile manufacture. The other 19 all agreed that, where missile performance requirements are more strict than those for conventional products, the materials and parts whose characteristics may be affected by the missile environment should meet the higher values necessary. In certain areas, missile requirements are far less than those of commercial television or radio. For example, life tests of hundreds of hours have no meaning for a product which is designed for a few minutes' operation. However, the acceptable quality level must, understandably, be higher in the missile industry than in those where failure means no more than temporary inconvenience, a service call, or an angry customer.

To summarize, testing in the guided missile industry is recognized as one of the most essential phases (1) to develop design information, (2) to aid in selection of optimum components, and (3) to assure quality control. Requirements are based on applications, always keeping in mind the importance of reliability.

Materials

In many fields, the operating conditions are so well known that materials may be selected from handbooks, and a cursory receiving inspection may be perfectly adequate. Missiles are not yet in this fortunate situation. Different types, or even different models of the same general type, have different environments. One may be designed for a life, another for 10. One may reach skin temperatures of 600 F while another may operate at 800 F. For optimum design, the responsible engineer must test the raw materials to ascertain their reaction to the expected environmental conditions. The combination of possible long inactive storage and short active life present new problems for which there are at present no standard test methods. To quote a producer who now has an op-

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NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* Presented at a technical session of the ASTM Second Pacific Area National Meeting in Los Angeles, Calif., September, 1956.

erational missile in the field, "Operational conditions are often so severe and diverse that one cannot fully anticipate the interrelation between even basic materials and their effect on equipment operation."

Most missile companies purchase materials (such as metals, plastics, rubber, varnish and lubricants) to Government specifications. However, half of the replies qualified their answer by such remarks as "Government specifications are used when they are considered applicable." It would appear that there is need for a careful review of Government specifications to see where they do not meet missile industry requirements. All except three of the companies queried stated that they sometimes write company specifications for raw material, either because there is no applicable Government publication or because they want more definitive requirements that are better pointed toward the end use of missiles.

Standard Parts

Guided missiles use hundreds of small "standard" parts such as electron tubes, resistors, clamps, connectors, capacitors, and the like; also tube fittings, nuts, bolts, and other mechanical hardware. Most of the missile producers feel that Government specifications for electronic parts are not adequate for the missile industry's needs and therefore prepare individual company descriptions of such standard parts. There are four reasons for the use of these company specifications:

1. To tighten requirements in order to improve performance; or, at least, to obtain a more appropriate and detailed description of the part as the prime reason. (The reasons why missile producers are not satisfied with Government specifications for materials and parts are detailed later.)

2. Of almost equal importance is the need for protection against changes by the vendor. This does not imply any trickery or unethical procedure by the vendor; he may honestly believe he is improving the product by the changes! Frequently, the vendor does not understand the true nature of the requirements. Sometimes the missile designer cannot reveal detailed requirements because of security. Perhaps he is using the part in a way the vendor never anticipated, making use of some secondary property which is of no interest to anyone else. The only way to assure suitable parts in the future is to prepare a detailed specification calling out all significant properties.

3. A third reason for company specifications is to obtain multiple sources. Even though company A makes a resistor which is completely satisfactory, and which can be ordered from the catalog at a reasonable price, it is not good to depend on only one source. No product of importance to the national defense should be dependent on one source, since this makes the plane or missile or gun vulnerable to natural calamities such as floods, fires, or hurricanes; and to man-made problems such as sabotage. Therefore, the missile manufacturer would prepare his own description of a resistor—knowing that company A's product meets all the requirements, but anxious to find another vendor who can also furnish suitable ones.

4. The fourth reason for preparing company specifications is to assist Receiving Inspection in their task. Since only certain properties are significant in that they affect the operation of the missile, only these need be checked. Company specifications help Inspection decide which values need be determined and what test methods to use.

The chief criticism of existing specifications is that the environmental criteria are inadequate, the acceptable quality limits are too low, and, statistically, the limits set by specifications are too broad. As one major producer put it, "Present specifications for resistors, capacitors, etc., provide no assurance as to the ability of these devices to survive in a guided missile environment." Several companies reinspect 100 per cent of supposedly "standard" parts to assure meeting the narrower limits required for missile service. They feel that certain special tolerance requirements may often be met more economically by screening standard parts than by attempting to purchase to these very narrow limits.

It is recognized that missile development is progressing far too rapidly for Government specifications to keep up. However, it is the author's opinion that a multiplicity of company specifications covering items which could be considered "standard" works a hardship on vendors and raises the price of the items. It is, therefore, suggested that technical groups which can prepare and issue specifications more rapidly than Government agencies concern themselves seriously with the problem of up-to-date specifications for the many "standard" parts commonly used in guided missiles.

Special Parts

Any product, whether automobile or radio, has some special items which are designed to meet its particular needs. The guided missile industry has many such special parts: valves, filters, servomechanisms, gages, and the like. Ordinary commercial parts cannot be utilized because they are too large, or too heavy, or unable to meet the guided missile requirements. Guided missiles demand subminiature items, because space is always tight. Similarly, parts must be as light as possible. Like any other airborne vehicle, missiles would suffer in performance if overweight.

In addition, structural parts such as castings, forgings, and extrusions may be specially designed for a given missile. Such parts are tested nondestructively to assure freedom from injurious defects. Also, one or more is often tested to destruction to prove design and to provide acceptance standards for the nondestructive examination.

Time of Testing

Tests on materials, parts, and components are run at three different times: (1) prior to inclusion in design, by engineers; (2) prior to use in the missile, by inspection; and (3) continuously during manufacture, by vendors and by missile manufacturers.

Engineering Evaluation

Before a material or part is definitely selected for a specific application, it is evaluated for this particular application, in the Engineering or Materials Testing Laboratory. Perhaps some of the properties listed in the Government specification are not significant for this use; or sometimes other characteristics which may not even be mentioned in the specification are of great importance. These engineering evaluation tests not only determine the suitability of the material or part for the application at hand but also investigate the effect of variables on essential properties. From the results of such engineering evaluation tests come the tolerance limits established as requirements for proper functioning of material or parts.

Usually, these evaluation tests are quite extensive, covering all anticipated missile environments. All the missile manufacturers answering the questionnaire on testing agreed that it is necessary to do some testing to destruction, both to establish the margin of safety and to improve reliability. While "testing to destruction" is often expensive, since it ruins materials and components which may cost a good deal, there is no other way to accomplish these desired results.

Receiving Inspection

Once a part has been selected for use and the requirements established by Engineering, it is then Purchasing's job to purchase such parts and Inspec-

tion's job to be sure the requirements are met. Frequently, missile producers find it more efficient to station inspectors at vendors' plants than to check everything as it enters the missile factory. Or, in some cases, there are resident Government inspectors in the vendors' plants who constantly check the quality of manufacturing and product. Therefore, "Receiving Inspection," as the term is used herein, denotes all inspection of a material or part prior to its incorporation in the missile, whether such inspection is actually performed at the vendor's or the user's plant.

Probably the greatest problem in inspection is the lack of standardized test equipment, particularly in the electronics field. Since missile designers are always trying to get the last bit of performance out of every part and component, tolerances are often much tighter than in other industries and sometimes tighter than the usual test equipment can measure. In the early days of missile production, one wondered whether the test equipment was checking the missiles, or the missiles were checking the test equipment! Now, missile producers are also building test equipment and are insisting that their vendors use equivalent equipment in checking items before delivery.

In the main, Receiving Inspection is a "Go No-Go" type of operation, aimed at rapid checks of important attributes on a large number of parts. This is possible because, as mentioned above, parts and materials are purchased to detailed specifications and are manufactured under Government or company surveillance. Also, parts are under constant check in the production control test.

Production Control Tests

Production Control tests, or "type tests," are run on a certain percentage of production parts to assure maintenance of acceptable quality. They are much more extensive than receiving inspection tests, frequently including operation under extreme environments such as heat, cold, shock, vibration, humidity, etc. If the items tested prove unsatisfactory, the sample size is increased, and *vice versa*.

Although it is common practice to accept or reject the entire lot on the basis of the admittedly severe production control tests, most vendors do not resent these tests. After all, the "type tests" are performed to specification requirements, which the vendor has agreed to meet. Moreover, if the test failure is nondestructive, the rejected item may be suitable for commercial use. And the information from such tests is of great value to suppliers in helping them improve their product.

These production control tests consist of three groups: (1) Static environmental tests, which include exposure to low temperature, high temperature, high humidity; corrosion, such as salt spray and fungus; and high altitude. Performance must be satisfactory before and after these environmental conditions. (2) Dynamic environmental tests, which include shock tests to simulate operational or handling shock; centrifuge tests to simulate steady-state acceleration; and vibration tests to simulate vibrations which may be encountered during transportation, storage, or operation. (3) Operational life tests, which include either steady or cyclic operation for the specified time.

To relieve the load on testing facilities within missile plants, a number of producers prefer to have their vendors run the production control tests in their own factories. In such cases, the missile manufacturer approves the test procedure and test equipment and usually has a representative present to witness the tests.

Functional Tests on Assemblies and Missiles

The tests, methods, and results of functional tests on major assemblies and complete missiles are classified, so cannot be discussed here. However, it can be stated that adequate tests are run at all assembly levels to assure satisfactory functioning.

Test Methods

Since the Government is the missile industry's only customer, naturally Government test methods are in general use. Many of the Government publications call for ASTM test procedures. Specifically, the ASTM methods for plastics, rubbers, electrical insulation and resistance, are universally used. Others in common use throughout industry are the techniques for elevated temperature testing of metals, including tension, creep, and stress-to-rupture.

One of the most valuable of the ASTM standards is E 98–53 T[1], the Reference Radiographs for Inspection of Aluminum and Magnesium Castings. These standards are an excellent example of the cooperation between Government and industry which has contributed so much to America's technical advancement. Originally prepared by a Naval laboratory, these reference radiographs were reproduced and published by ASTM. They now provide a definite reference for inspection laboratories, foundries, and users of castings, thus preventing misunderstandings. Other radiographic standards for steel castings (E 71–52[2], Industrial Radiographic Standards for Steel Castings), and weldments (E 99–55 T[3], Reference Radiographs for Steel Welds) are similarly used.

As previously mentioned, some manufacturers find it economical to reinspect 100 per cent of certain parts in order to meet special missile requirements. However, statistical quality control is in general use throughout the missile industry. The sampling procedures conform to those in MIL-STD-105, Sampling Procedures and Tables for Inspection by Attributes.

Techniques Needed

When questioned as to the adequacy of present test procedures to evaluate materials for missile applications, only one-sixth of the companies expressed satisfaction. One-third of those replying stated that, although generally good enough, today's test methods require modification for elevated temperature work. The other half of the missile industry replied that both Government and ASTM test procedures are not suitable for missile work.

It is often said, "Material does not care whether it is to be used in a hammer or in a missile," which is true to a certain degree. However, test procedures which are entirely different from the actual service requirements cannot accurately evaluate materials for a specific industry.

An example is ASTM Standard E 21–43[4], Short-Time Elevated Temperature Tension Tests of Metallic Materials. The minimum time for heating specimens prior to testing, in order to assure equilibrium, is "in no case. . . less than one hour." Some materials will deteriorate during one hour of exposure to elevated temperatures; others may (because of precipitation hardening) actually increase in strength. Whatever the result, it will have no significance for the missile designer whose product will be exposed to elevated temperatures for only minutes or seconds.

Similarly, the test procedures for both room and elevated temperature

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[1] 1955 Book of ASTM Standards, Part 2, p. 1419.
[2] 1955 Book of ASTM Standards, Part 1, p. 1664.
[3] 1955 Book of ASTM Standards, Part 1, p. 1713.
[4] (Recommended Practice), 1955 Book of ASTM Standards, Part 1, p. 1605.

tension tests of plastics (ASTM Methods D 638–52 T[5] and D 759–48)[6] are not compatible with missile environments, either in rate of loading or time of heating.

It is suggested that separate test procedures should be prepared to determine properties of special interest to the missile industry. Many of the "grades" or "classes" would be applicable to both missiles and aircraft, but there would be some procedures which would be closely tied to missile environments. The greatest need at present is for a standard test for short-time (from 5 sec to 15 min) elevated temperature properties; a great deal of work is being done on this problem, but because of widely varying test specimens and methods, data from different companies cannot be consolidated.

Other areas where test procedures for missile applications are needed include determination of surface resistivity; adhesive bonds; thermal conductivity; properties of elastomers in contact with fuels peculiar to missiles; degradation of properties as the result of combined time and temperature. An ideal test, as one missile engineer suggested, would include the "simultaneous test envelope of all missile conditions." The parameters of this test envelope would, of course, vary from one missile to another, but the test methods could be standardized, using times, loading rates, and heating rates which are compatible with missile environments.

Special Test Equipment

Since neither the Government nor the technical associations have, at present, test procedures that are truly applicable to missiles, the industry is working on its special problems both as individual companies and through the Aircraft Industries Assn. One field suggested for future ASTM work is the testing of structural plastic laminates at elevated temperatures. This problem, which is of real concern to a number of missile manufacturers, requires new heating methods to produce the desired temperature rise within a period of seconds rather than hours, and special instrumentation for the rapidly applied loads to simulate missile environments.

In the testing of structural metals at elevated temperatures, the missile industry is now using a number of different types of equipment in an effort to simulate rapid heating and rapid loading. Some laboratories use immersion in heated liquids; others employ quartz lamps for radiant heat; still others attempt to produce rapid heating rates by induction heating. One of the special pieces of apparatus used at the author's plant uses oil as the heating medium. Test coupons (and the supporting structure) are immersed in a flowing stream of heated oil. By changing the velocity of the fluid, heating rates can be varied from 5 to 150 F per sec. Loads are applied hydraulically, up to 25,000 lb tension or 40,000 lb compression, flexure, bearing, or shear, with an accuracy of ±20 lb. Because of the nature of the oil used, this unit is limited to temperatures of 650 F. For higher temperatures up to 1100 F, a similar unit utilizes molten salt as the heating medium. Plans are under way to construct a third unit with molten metal, for tests to 2000 F. Another missile manufacturer employs radiant heating, using quartz lamps as the heat source. Although the lamps are rated at 1000 w, they can be used as high as 2600 w with a corresponding decrease in life. To increase heating rate, parts may be coated with lamp black. Surface temperatures can be raised as much as 200 F per sec by this means. It is hoped that, in the near future, there will be some standard test methods and uniform test equipment which can be purchased as tensile machines can now.

Since sudden shock loading may be incurred during missile launching and flight, a new precision instrument has been developed for controlled shock simulation. The engineering test laboratories at the author's plant have designed a small device (called HYGE) which is capable of producing extremely high loads instantaneously, with precision wave form control. This actuator is extremely versatile and can provide peak acceleration levels from 10 to 500 g. Deceleration can also be controlled, for a wide variety of deceleration waveforms. High-level impact shock up to 5000 g can be developed for short time duration. This special equipment, which is desirable for accurate testing of missile components and materials, is being made available to other companies.

To meet the vibration requirements which are peculiar to missiles, a number of different types of equipment are being manufactured. Frequency ranges from 2 to 2000 cps and force ratings from 300 to 62,000 lb are available. To simulate steady-state acceleration, different sizes of centrifuges are employed which can produce up to 300 g.

Destructive versus Nondestructive

It is essential to carry a number of tests to destruction on both materials and parts in order to establish the margins of safety. As experience in the field of missile engineering is gained from a number of flights under various environmental conditions, the amount of destructive testing necessary will, no doubt, decrease. At the present time, however, most authorities on reliability and all of the missile engineers replying to this question agree that it is necessary to carry tests past the design proving stage to failure on many components.

This does not imply that nondestructive testing is not widely used and recognized as important in the guided missile industry. On raw materials the usual nondestructive inspection techniques, radiography, ultrasonic, penetrant inspection, magnetic particle analyses, conductivity meters, eddy current inspection, and the like, are all employed. Components are put through functional or operating tests which are, of course, nondestructive.

Summary

The author has attempted to show why the nature of the guided missile produces special problems in the field of testing and evaluation. The missile industry recognizes these special requirements, as is shown by their development of company specifications and of highly specialized test methods and equipment to meet their particular needs. Testing on all levels from original engineering evaluation through manufacture is an integral, important part of missile development. It is hoped that technical groups like the American Society for Testing Materials will recognize the differences between missile environments and those encountered by other aircraft or airborne vehicles. Such a group as ASTM can make a valuable contribution to the over-all efficiency and economy of the national defense effort by helping the missile industry standardize its testing procedures and equipment.

[5] Tentative Method of Test for Tensile Properties of Plastics (D 638-52 T), 1955 Book of ASTM Standards, Part 6, p. 207.

[6] Methods of Test for Tensile and Compressive Properties of Plastics at Subnormal and Supernormal Temperatures (D 759-48), 1955 Book of ASTM Standards, Part 6, p. 230.

DISCUSSION

MR. CHARLES E. WALDEN[7]—Are the rapid load and rapid heating tests conducted simultaneously or individually?

MRS. REBECCA H. SPARLING (*author*).—We have tried three ways: heating first and then loading; loading first and then heating; and heating and loading applied simultaneously.

When we do apply the heat and the load simultaneously we are dealing with thermal gradients, which makes it difficult to use the resultant data for design. Therefore, we bring specimens to temperature usually within five seconds. They are then loaded at such a rate as to reach the yield point in five seconds in the case of the standard tension, shear or bending tests. The compression test takes a little longer to heat, because the specimen is quite chunky and will not heat in five seconds.

MR. WALDEN.—To apply it simultaneously makes it too difficult to use?

MRS. SPARLING.—We could reduce the data, but we did not know what we had. We cannot use thermocoupled specimens for the actual run. These are run through first to determine the heating rate. The presence of the thermocouples would interfere with results on the regular tests.

MR. CECIL R. WALDRON[8]—Has the author tried heating by electrical conduction, or molecular baths?

MRS. SPARLING.—We have tried resistance heating where we reached temperature almost immediately, but we felt that this was not as good for our purposes as the immersion heating. Immersion has the advantage that it can be used for structures where it simulates exactly the thermal gradients occurring in flight, because the heat is coming from the outside in. Resistance heating goes through the entire specimen at once. This is not what happens in flight.

We have a very good check between some of these tests which are run with resistance heating and the ones which are heated to the same temperature in the oil bath.

MR. KENNETH R. JACKMAN.[9]—As a coworker with Mrs. Sparling, may I add one other statement to this?

We should like to be sure that people understand our problem thoroughly. We have these two items that Mrs. Sparling has discussed: HYGE; and the high temperature equipment for rapid heating. These are not classified, therefore we would be glad to help anybody who would like to have information. Brochures and copies of test reports will be made available on proper request. On the other hand, there is a new problem that has come up in the last couple of weeks, and I would like to submit it to ASTM for consideration. That one is high-acoustical sound testing. That is something brand new.

What we would like to do is to get a correlation between the high-acoustical pressures that will disturb electronic equipment (the very sensitive acoustical guidance equipment that we have in missiles) and a logical method of testing on the ground.

That can only be done by different types of air sirens, loud speakers, and other things like acoustical chambers on the ground.

I believe that ASTM can help us a great deal in correlation of the best information on acoustical test facilities on an industry-wide basis.

MR. V. N. KRIVOBOK.[10]—Some of the things that the author mentioned, such as the rate of load application to the possibility of phase changes, an important consideration of internal stresses being induced by the expansion characteristics, etc., have been pondered before by quite a few of us.

If some of us have not been as active as we should be, perhaps, it is not because of lack of interest. It is because we cannot understand the significance or importance of any test, without knowing precisely what it is you need to know.

I speak not as a representative of any commercial company, but as a metallurgist. It is simply that there is no way for us to apply in our work the very specialization that you need in order to learn what you must learn.

MR. P. JAMES RICH (*chairman*).[11]—I have been for many years in the Ordnance Department, as a chemical engineer, and on metal work, and ammunitions. I am one of those who has been on the Ordance Specifications Committee since 1940, and I know just exactly what Mrs. Sparling means when she says that Government specifications, do not cover a lot of the problems involved.

It was for this reason that I suggested that the problems be brought before the ASTM, because I feel that the Society might help by having some of the problems discussed by appropriate committees.

I wanted to bring out where ASTM can be of the utmost help in the new guided missile field and I want to thank Mrs. Sparling very kindly for a very excellent delivery.

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Controlling Accuracy with a More Rapid Sand Cone Density Test

By Bonner S. Coffman

Test site leveling can be minimized or eliminated by a rapid test that controls inaccuracy from this source.

THE IN-PLACE density test using sand-cone apparatus with base plate assumes a level soil surface so that the plane of the bottom of the plate and the plane of the soil surface are conjugate or contiguous. Leveling the soil surface requires care and is time consuming. In soils containing coarse material, leveling is difficult if not impossible. The alternative to leveling requires two volume determinations for each density test—the first measuring the volume of the void below the bottom of the plate and the second, measuring this plus the volume of the test hole. The two-test procedure is accurate but requires about twice as much time and more equipment.

Calculations

If the two-test procedure is not followed and there is a void between the plate and the soil surface, the density determination will be in error. Assuming a void of any shape with an average height of H, the resulting per cent of error in any density determination can be calculated. Figure 1 shows the results of such calculations for soil volumes of 0.05 and 0.1 cu ft. The calculations are based on a 6.5 in. diameter opening through the base plate—a size commercially available. The graph shows that if the average height, H, exceeds 0.052 in. in a 0.1-cu-ft hole, the resulting density will be over 1 per cent in error. Void heights of this magnitude are very small and in the field can easily go undetected.

If the void of average height, H, is filled with sand of known density, the accuracy of the resulting density test can be calculated. Figure 2 shows the results of such calculations for a 0.1-cu-ft test hole in soil at 140 lb per cu ft dry density and 7 per cent moisture content. The combination might represent a compacted gravel base. The density of the sand used is 38,200 g per cu ft or about 84 lb per cu ft. The peripheral ring of sand caused by its angle of repose is neglected in the graphs of this report.

Three curves are shown. The one labeled "true" represents the use of the actual soil moisture content. The curve labeled "average" represents use of the moisture content obtained by mixing the density test sample and the void-filling sand. The third curve labeled "worst" uses the least accurate moisture content possible. It represents the condition in which all sand used to fill the void under the plate is retained in a 1000-g moisture content sample.

Similar calculations may be made for soil having a dry density of 90 lb per cu ft and a moisture content of 32 per cent which might represent a compacted clay fill. Figure 3 shows the results of such calculations together with the curves of Fig. 2. This graph shows that the least accurate test condition occurs with 90 lb per cu ft soil when the moisture content used is the "worst" condition, that is, all of the void-filling sand is retained in a 1000-g moisture content sample. Densities resulting from this combination, only, are greater than the actual soil density as shown by the "plus" on the curve. This "worst" condition is improbable and in any event can easily be avoided. Study of the remaining curves shows that by selecting the desired test accuracy the controlling height H is known. Using this value the weight of sand can be determined that will fill the corresponding volume.

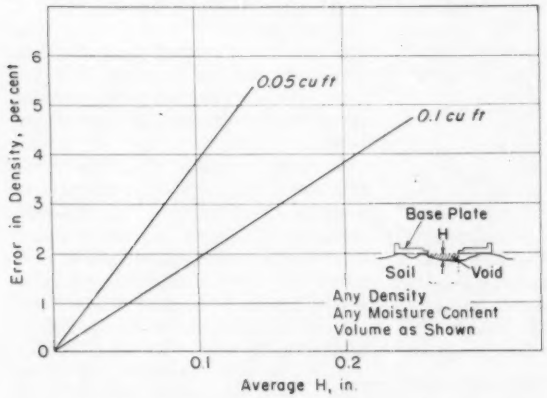

Fig. 1.—Density Error *versus* Average Height H of Void.

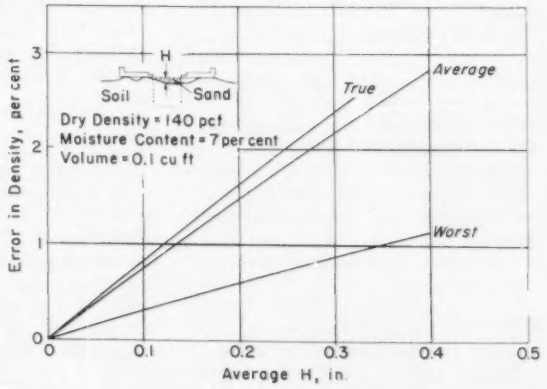

Fig. 2.—Density Error *versus* Average Height H of Sand-filled Void.

BONNER S. COFFMAN, soils engineer, District of Columbia Department of Highways, and lecturer at The George Washington University, is an active member of ASTM Committee D-18 on Soils for Engineering Purposes.

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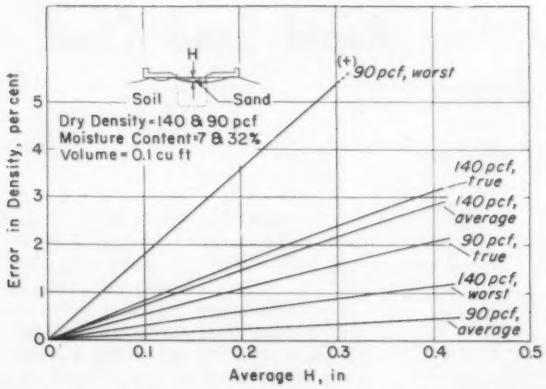

Fig. 3.—Density Error *versus* Average Height *H* of Sand-filled Void.

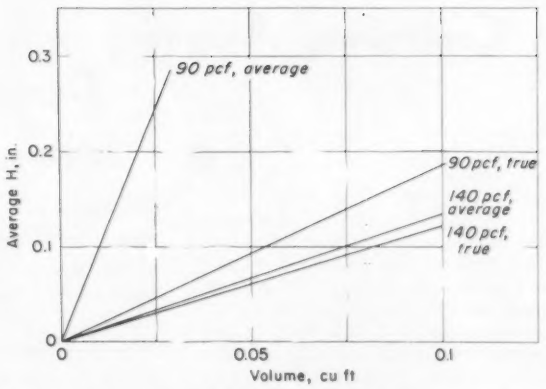

Fig. 4.—Average Height *H versus* Soil Volume for 1 per cent Error in Density.

Amount of Error

Selecting 1 per cent as the maximum permissible error and plotting the average height, *H*, values *versus* the corresponding density test volumes will give a graph such as Fig. 4. From this graph it is seen that the smallest permissible *H* for 1 per cent error in density is 0.122 in. for a 0.1-cu ft soil volume. Multiplying the corresponding void volume by the unit weight of the sand gives 90 g, roughly a handful of sand.

Figure 5 shows the per cent error in the "average" moisture content if 90 g of sand is used, that is, if the maximum error in density is 1 per cent. If the true soil moisture content is determined, no error results. From the graph it can be seen that for a 0.1-cu-ft volume in a soil having a moisture content of 32 per cent the test would show a moisture content of 32 (100 − 2.13) = 31.32 per cent which is sufficiently accurate for most purposes.

Application

In applying these results to field use the desired test accuracy is fixed and the corresponding weight of void-filling sand determined. For example, if a maximum density error of 1 per cent is desired in a 0.1-cu ft test, as in the above calculations, this weight is 90 g. Seating the base plate over the spot to be tested, the inspector pours the 90 g of sand into the plate opening, Fig. 6. This figure also shows the containers used to transport the sand—three or four of these can be easily carried in trouser pockets. The sand is next leveled to the plane of the base plate bottom by rotating the screed, Fig. 7. This figure also shows the screed used which in this photo is a piece of light gage sheet metal. If there is not enough sand to fill the void to the bottom plane of the base plate, the inspector knows that the test accuracy will not be within 1 per cent. He moves the plate to another location and repeats the procedure. When there is a surplus of sand it is discarded, and the test hole is completed in the usual manner. In weighing the density sample the void-filling sand is considered a part of the density test. In determining the moisture content of the soil with the sand, the inspector may follow one of two procedures. If the sand and soil can be easily mixed the "average" moisture content is determined. If the soil and sand cannot be easily mixed, the "true" moisture content of the soil is determined.

Screed

The screed used in this report is made of sheet steel 0.013 in. thick. The flexibility of the sheet metal absorbs shocks caused by improper rotation of the screed. Each end of the screed has two hack saw blade segments bolted to it to reduce wear and to permit adjustment of the screed. In making the screed, allowance must be made for the effect in screeding sand of the plane of the screeded surface being lower than the plane described by the screed edge. For the sand used in this report the effect is compensated for by setting the screed edge 0.013 in. above the plane of the base plate bottom. The accuracy of a setting can be checked by comparing the amount of sand required to fill the cone and base plate on a level surface with the amount required on a screeded surface. In this example, if the screed is set so that the plane of the screeded sand is 10 g lower than the base plate bottom plane the density error will be increased 0.17 per cent. An increase in the screeded plane height will similarly decrease the error.

It is not essential that the screed bottom be set to describe the bottom plane of the base plate. If, however, the screed describes any other plane, it is necessary that the weight of sand filling the funnel and base plate be determined on a screeded surface.

In selecting a sand to fill the void, a heavier sand than that used in this example will give better results. In calculating the weight of void-filling sand, a unit weight reasonably consistent with the leveling procedure must be used. This unit weight will usually be lower than the unit weight obtained by "calibrating" relatively large volumes of sand. It can be determined by dividing the weight of screeded sand required to fill the base plate within its lower flange by the volume

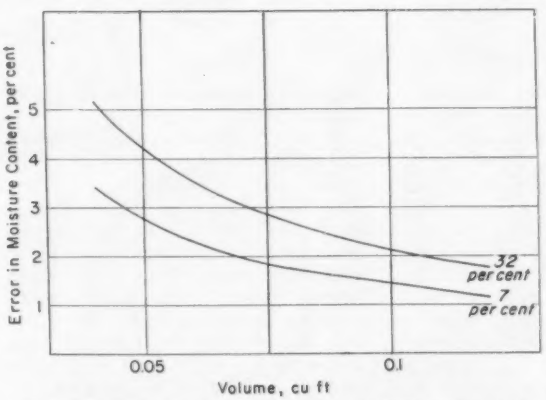

Fig. 5.—Error in Average Moisture Content *versus* Soil Volume for 1 per cent Error in Density.

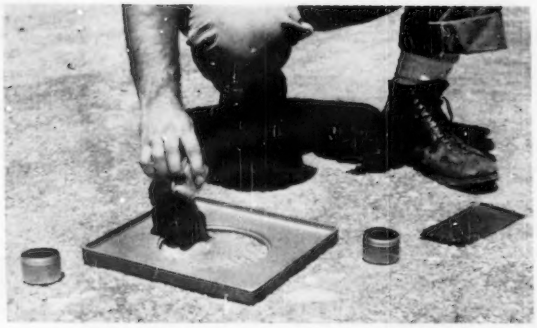

Fig. 6.—Base Plate Over Spot to Be Tested.

Fig. 7.—Sand Leveled to Plane of Base Plate.

bounded by the lower flange.

Variations in the unit weight of the void-filling sand show little effect on the density test accuracy. In this example a 5 per cent decrease in the unit weight of void-filling sand from the assumed 38,200 g per cu ft will increase the error about 0.07 per cent. An increase in the unit weight will similarly decrease the error.

The effect of neglecting the peripheral ring of sand limited by its angle of repose is conservative and simplifies the calculations. In the example presented, the effect is to decrease the density error about 0.1 per cent for angles between 34 and 45 deg.

Conclusions

Based on field experience, it is believed that the actual density error from following the above procedure is less than 0.8 per cent with a corresponding moisture content error of less than 1.4 per cent. The inspectors like the method. It decreases or eliminates the time previously spent in leveling the soil surface. It is especially suited to soil with large particles and to soils compacted by nonsmooth wheeled equipment.

Evaluation of Thermal Stability of Flexible Insulating Sleeving*

By E. B. Snyder and Ralph Fantini

ELECTRICAL insulation components and systems are being subjected to very intensive study by the American Institute of Electrical Engineers, ASTM, and other groups, to develop methods for evaluating the stability of insulating value under varying degrees of thermal stress. Sleevings, although they constitute a small part of any large apparatus, should be included in these studies, since the choice of the correct type and quality may be essential to the proper operation and adequate life of the assembly.

ASTM methods D 350[1] and the related specifications D 372,[2] as they presently stand, do not contain adequate test methods or evaluation criteria to permit proper selection of sleeving for a given application.

Section B on Treated Sleeving of Subcommittee VII of ASTM Committee D-9 on Electrical Insulating Materials is at present developing new test methods for vinyl-coated fiberglass braid, which methods will give sufficient information on the physical, chemical, and electrical properties of this type of sleeving to enable its proper use. Subsequently methods will be developed for silicone rubber and for both silicone and organic varnish-coated sleeving.

Comparative results on various vinyls and varnish materials—the difficulty of predicting performance at operating temperatures from accelerated aging tests at temperatures above chemical stability range of the material.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the authors. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* Presented at a meeting of ASTM Committee D-9 on Electrical Insulating Materials, Philadelphia, Feb. 14, 1956.

[1] Methods of Testing Flexible Varnished Tubing Used for Electrical Insulation (D 350 – 48), 1955 Book of ASTM Standards, Part 6, p. 839. Tentative Revision of Methods D 350, Part 6, p. 843.

EDWARD B. SNYDER, vice-president and chief engineer, Bentley, Harris Manufacturing Co., Conshohocken, Pa., received his Ph.D. in physical chemistry from MIT, in 1939. His professional interests include research, development, and production of electrical insulation, and he has long been an active member of ASTM Committee D-9 on Electrical Insulating Materials.

RALPH FANTINI, technical director, Bentley, Harris Manufacturing Co., Conshohocken, Pa., received his B.S. degree from Drexel Institute of Technology in 1955.

One of the major deficiencies of the present test method is in the evaluation of temperature stability. Some tests are specified to be conducted at or below the operating temperature and for a very short time duration. The criteria are visual and subject to varying interpretation.

Most sleevings available today will meet the requirements of Specification D 372,[2] even though there is a great variation in the stability of the chemical and electrical properties of various products. There is a need for methods that will bring out the superior features, capabilities, and limitations of each type. The data here presented represent the results of an attempt to provide such a method, with specific reference to vinyl-coated fiberglass sleeving, although the method should be applicable equally to most other types.

In the manufacture of vinyl-coated fiberglass sleeving, the need was felt early for tests that would show the retention of the insulation value of the sleeving under operating conditions, but which would be accelerated sufficiently to be useful as a means of evaluating the relative merits of different coating compositions.

The dielectric breakdown value, as a criterion for evaluation of the usefulness of the sleeving as an insulator after conditioning, was selected as being easily measured in most laboratories and superior to any visual observation. A single high temperature (232 C) was used in the initial development work, since it gives results in a short time and is the temperature specified by Method D 350[1] for the resistance to potting temperatures and is generally used as a production control test.

In the early development work, dielectric breakdown values were obtained after each hour of conditioning at 232 C, until a single reading of 2000v or less was obtained. Coatings were rated according to the number of hours required to reach this value. This simple test proved adequate for comparison of sleevings where the coating compositions were similar as to types of resin and plasticizer systems used.

When time and oven space permitted, tests were made on sleevings having various coatings at temperatures of 200 and 150 C. The conditioning was continued until the short-time dielectric breakdown decreased to a value of one-half the rated average, and the evaluation of each sleeving was made according to the time required to reach this value.

TABLE I.—HOURS TO REACH HALF THE SHORT-TIME DIELECTRIC BREAKDOWN RATING. SLEEVING SIZE NO. 8.

	200 C		150 C	
	Unflexed	Flexed	Unflexed	Flexed
Polyvinyl chloride M[a]	80	...	1000	...
Polyvinyl chloride P[b]	80	18	1950	500
Varnish	25	0	725	0

[a] Monomeric plasticizer system.
[b] Polymeric plasticizer system.

Table I shows typical results obtained on two vinyl-coated sleevings and one high-temperature organic-varnish-coated sleeving.

The values at 200 C (unflexed) indicate that the two vinyls are about equal in thermal stability while the varnish is much poorer. An entirely different picture is presented at 150 C, where the superiority of the polymeric plasticizer system is evident and the relative position of the varnish is improved.

The figures obtained on the flexed specimens show that the vinyl can be flexed after conditioning for at least a portion of its expected life, while the varnish cannot be flexed even before conditioning. This points up the obvious advantage of thermoplastic materials in assembly operations. Flexing tests on the PVC-monomeric plasticizer systems have not been completed, but it is expected that they will give results intermediate between those obtained with the varnish and those obtained with the PVC-polymeric plasticizer system.

These results lead to the decision that at least three temperatures should be used in the accelerated tests and that the rate of decrease of the dielectric breakdown should be determined at each temperature and plotted to show the effect of aging temperature. Since reaching this decision we have made a reasonably complete study of one size of one type of sleeving, consisting of fiberglass braid coated with a plastisol composed of PVC and an all polymeric plasticizer system. Tests were made at five temperatures on undisturbed specimens and at four temperatures on specimens flexed after aging.

Tests are under way or contemplated on other materials and at lower temperatures, as well as on different sizes of the same material. Earlier tests at 130 C were inconclusive, since the available samples were sufficient for only 3000 hr of conditioning at which time the sleeving had not reached the end point of the test.

This new series of tests was made on grade A-1 vinyl-coated fiberglass, Awg size No. 8, to eliminate the variables of size and exposed surface. Specimens were 6-in. lengths of sleeving. Sufficient numbers were used to permit ten dielectric breakdown tests at each time interval, two breaks being taken

[2] Tentative Specifications for Flexible Treated Sleeving Used for Electrical Insulation (D 372 – 53 T), 1955 Book of ASTM Standards, Part 6, p. 818.

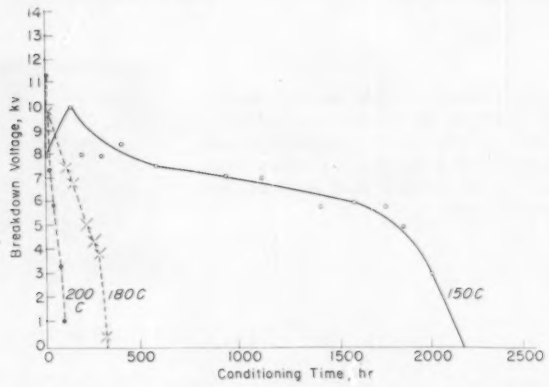

Fig. 1.—Breakdown Voltage *versus* Conditioning Time for Unflexed PVC-P Sleeving at 150, 180, and 200 C. (See extended drawing, Fig. 2.)

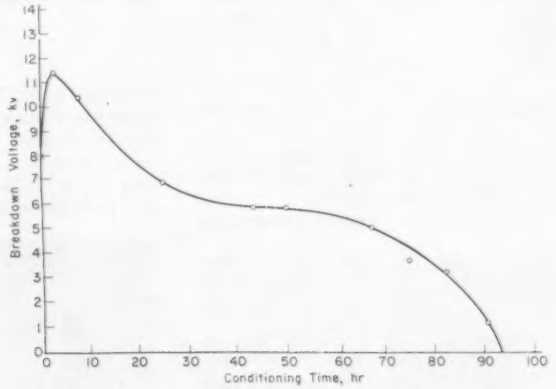

Fig. 2.—Breakdown Voltage *versus* Conditioning Time for Unflexed PVC-P Sleeving at 200 C.

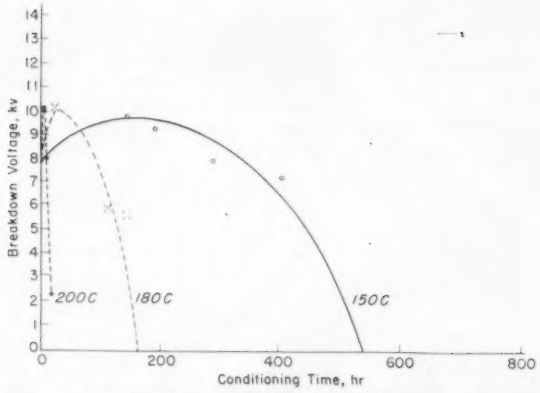

Fig. 3.—Breakdown Voltage *versus* Conditioning Time for Flexed PVC-P Sleeving at 150, 180, and 200 C. (See extended drawing, Fig. 4.)

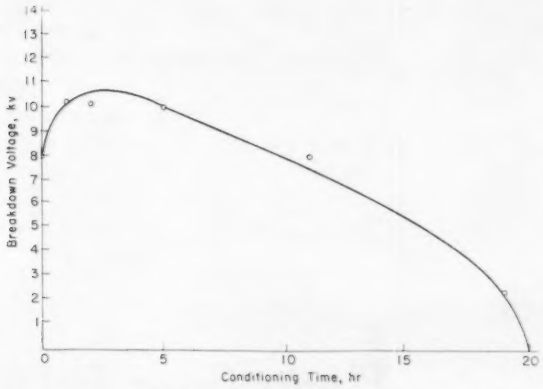

Fig. 4.—Breakdown Voltage *versus* Conditioning Time for Flexed PVC-P Sleeving at 200 C.

on each piece. The inner electrode was No. 8 bare copper wire and the outer electrode, 1-in. foil wrap. Voltage was raised at a rate of 500 v per sec.

Specimens were conditioned in mechanical convection ovens of the Freas type. Only the sleeving under test was conditioned in an oven to eliminate contamination by volatile matter from other materials.

The first series of specimens was tested without flexing. A second series was run in which each specimen was flexed after conditioning by bending the specimen 180 deg back upon itself and applying slight pressure 1 in. from the crease.

Temperatures at which the unflexed specimens were tested were 150, 180, 200, 215, and 232 C, while the flexed specimens were conditioned at 150, 180, 200, and 232 C.

Figure 1 shows the dielectric breakdown in kilovolts *versus* the conditioning time at 150, 180, and 200 C. The curves shown required such large differences in time scale to show their shape that they were plotted separately for purposes of calculation. Figure 2, for 200 C, is an example of the results for the higher temperatures. At each conditioning temperature, the dielectric breakdown increases initially, goes through a maximum, then drops back to a point slightly below the initial value, where it levels out for a period, and then begins a more rapid decrease at the end of the conditioning period.

The initial rise may be attributed to a combination of additional fusion of the plastisol and expansion of the coating. The accelerated rate near the end of the test may be caused by depolymerization of the resin and plasticizer with resultant loss of volatile components and shrinkage of the coating.

Figures 3 and 4 are the corresponding curves for the flexed specimens. In these curves the initial rise is again apparent, but the intermediate flat portion of the curves is missing and the rate of decrease of dielectric breakdown is much greater. A possible interpretation of the difference in shape of the curves is that the flexing has removed the effect of the mechanical support afforded by the glass braid. The scatter of the data was much greater in these tests and drawing of the curves consequently much more uncertain.

Figure 5 is a plot of the logarithm of the rate of decrease of the dielectric breakdown *versus* the reciprocal absolute conditioning temperature. This is similar to the treatment used by Dakin,[3] except that the varying slope of the kilovolt *versus* time curves forced the use of graphical integration to obtain an average slope, which it was believed should not be interpreted strictly as a chemical rate constant due to the heterogeneous nature of sleeving as opposed to insulation consisting of a single material.

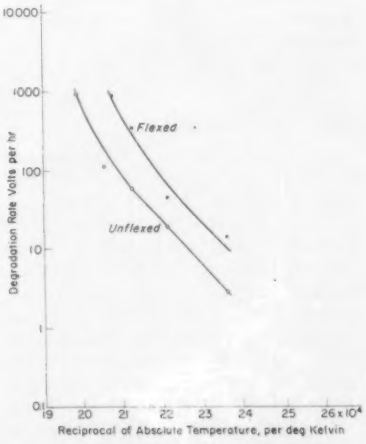

Fig. 5.—Degradation Rate *versus* Reciprocal of Conditioning Temperature for Flexed and Unflexed PVC-P Sleeving.

The points obtained at 150, 180, and 200 C on the unflexed specimens fall on a straight line, and the 215 C point is reasonably close, but at 232 C the rate of decrease is greater than would be predicted from the lower points. The acceleration of the aging at 232 C is probably too great for reliable results, and it is believed that 200 C should be the highest accelerated test temperature.

These temperatures are all far enough above a reasonable operating temperature for the material to make questionable the extrapolation of the curves to lower temperatures. As mentioned earlier, incomplete tests at 130 C indicate departure from this straight line.

The question of whether or not to flex the specimens remains to be answered. Flexing shows the initial superiority of the thermoplastic material over the more brittle varnished types and serves to shorten the duration of the test. On the other hand, it is hard to perform reproducibly and does not simulate any service condition. It is our opinion that it should not be included in the test method being developed.

Summary

1. There is need for more adequate test methods and specifications on the thermal stability of insulating sleevings.

2. The development of a simple method for comparing sleevings has been described and results obtained on one such sleeving presented.

3. Much further work needs to be done to determine the effect of size, thickness of coating, type of supporting

[3] T. W. Dakin, "Electrical Insulation Deterioration as a Chemical Rate Phenomenon," *Transactions*, Am. Inst. Electrical Engrs., Vol. 67 pp. 113–118 (1948).

braid, and other variables of the construction.

4. Properties should be investigated at lower temperatures to enable the method to be expanded to include accurate predictions of the life of the sleevings under operating conditions.

[4] Natvar Corp., Woodbridge, N. J.

DISCUSSION

MR. R. C. BARTLETT.[4]—Why does this initial part of the breakdown *versus* aging time curve have a positive slope?

MR. E. B. SNYDER (*author*).—It is our belief that some additional fusion may take place in the coating, increasing its density, and that simultaneously the coating expands, providing a greater space factor.

INTERNATIONAL STANDARDIZATION

Plastics Group Holds Sixth Annual Meeting

By C. H. Adams and E. M. Kline

TECHNICAL Committee 61 on Plastics of the International Standards Organization set new records for attendance and accomplishment at The Hague meeting during the week of September 17 to 22, 1956. Approximately 90 delegates from 15 nations acted on 23 Draft ISO Proposals and Draft ISO Recommendations during the six-day meeting. Hungary, Poland, Rumania, and the U.S.S.R. were represented for the first time.

G. M. Kline, chief of the Division of Organic and Fibrous Materials at the National Bureau of Standards, presided as meeting chairman. D. J. van Wijk of T. N. O., Delft, was co-chairman and C. L. Condit of the Society of the Plastics Industry, served as secretary, assisted by N. A. Skow of the U. S. delegation and J. Smit of the Hoofdcommissie voor de Normalisatie in the Netherlands.

One of the most important of several significant developments was the agreement that the primary purpose of the international committee is to develop test methods for commercial use based on existing national standards. A direct result of this policy clarification was the adoption of draft ISO proposals for impact testing based on U. S. (ASTM) and German (DIN) standards. Related to the policy understanding was the adoption of three alternate standard test atmospheres as shown in Table I one of which reflects U. S. practice in the plastics field. It was also indicated that the development of ISO test methods would be of direct interest to scientific investigations and the compilation of engineering data.

A milestone in TC 61 history was passed when five methods were approved for submission to the ISO Council for promulgation as ISO Recommendations. An ISO Recommendation is the counterpart of an ASTM tentative. These methods cover the determination of (1) Temperature of Deflection under Load (Heat Distortion), (2) Water Absorption, (3) Apparent Density of Molding Powders Which Can Be Poured from a Funnel, (4) Apparent Density of Molding Powders Which Cannot be Poured from a Funnel, and (5) Acetone Soluble Matter of Phenolic Moldings.

Future Meeting Plans

The U. S. invitation to hold the 1958 meeting in America was accepted. Plans are already under way for this to precede or follow the fall meeting of ASTM Committee D-20 on Plastics. A symposium on plastics testing in which the foreign delegates will be invited to participate will be scheduled during the week of the ASTM sessions. A. C. Webber of the American Group is program chairman for the symposium.

The 1957 meeting will be held in Switzerland, probably in July, preceding or following the Congress of the International Union of Pure and Applied Chemistry.

Working Group Activity

A comprehensive list of equivalent terms relating to plastics in English, French, German, Italian, and Spanish was completed by the Working Group on Nomenclature and Definitions. This list of terms, with the addition of the Russian equivalents and unofficial definitions of some of the terms, will be circulated to ISO member bodies as a Draft ISO Recommendation. The group will now undertake the preparation of official definitions of the terms.

The Working Group on Mechanical Strength Properties, in addition to preparing the two Draft ISO Proposals on impact testing, approved a test method for Flexural Properties of Rigid Plastics as a Draft ISO Recommendation.

The Working Group on Standard Laboratory Atmospheres and Conditioning Procedures recommended that the ISO Technical Committee on Atmospheric Conditioning endeavor to obtain agreement on one standard atmosphere for all materials. In the meantime, as already mentioned, two Draft ISO Proposals have been revised to include three alternate sets of conditions, namely,

TABLE I.

	Atmos. A	*Atmos. B* (Essentially ASTM D 618)	*Atmos. C*
Relative humidity..	65 ± 5%	50 ± 5%	65 ± 5%
Temperature	20 ± 2 C	23 ± 2 C	27 ± 2 C

The Working Group on Thermal Properties prepared two Draft ISO Proposals for the determination of (1) melt flow index of polyethylene and polyethylene compounds, and (2) incandescence resistance of plastics.

The Working Group on Physical Chemical Properties has been the most productive of methods in TC 61. It currently has four circulating as Draft ISO Recommendations, namely, (1) Boiling Water Absorption of Plastics, (2) Methanol Soluble Matter of Polystyrene, (3) Free Phenols in Phenol-Formaldehyde Moldings, and (4) Free Ammonia and Ammonium Compounds in Phenol-Formaldehyde Moldings. At The Hague meeting, it approved the circulation of the following as Draft ISO Recommendations: (1) Determination of Bulk Factor of Molding Materials,

(*Continued on page 98*)

The Bookshelf

Atoms and Energy

H. S. W. Massey; Philosophical Library, Inc., New York, N. Y.; 168 pp.; $4.75.

In this book the author attempts to discuss the scientific aspects of the development of atomic physics and the large-scale liberation of atomic energy for nonscientific readers. However, scientific readers who lack a knowledge of atomic physics will find the book most useful.

The first chapter presents a fairly simple discussion of the building blocks of matter—electrons, protons, neutrons, and atoms. This is followed by a consideration of the combination of atoms and its significance in the release of chemical energy, preparing the reader for a discussion of the release of energy by changes in the nucleus of the atom.

Having developed the background information, the author then devotes two chapters to the large-scale release of nuclear energy and its peacetime applications.

The book is concluded by a chapter on the present-day state of the art in pure atomic physics. Unfortunately, the manuscript for the book was prepared several years ago and this chapter is somewhat out of date. It would have been better had the author used this chapter to reveal the importance of fundamental research in atomic physics without attempting to present it as a current exposition on the subject.

The book is generally readable and interesting. It may be used to advantage by a limited audience but it is not recommended for the nonscientific reader.

George H. Calkins

Resistance Welding, Theory and Use

American Welding Society; Reinhold Publishing Corp., New York City; 160 pp.; $4.50.

It is not unusual that the art precedes the science and it is not unusual that the transition period from one to the other is a difficult one. In almost every subject or industrial process "shop" terms and "shop" definitions are inaccurate and misleading and often lead to misunderstanding and general confusion.

The resistance welding of metals and alloys has for many years been going through such a transition period. This book written by the Resistance Welding Committee of the American Welding Society under the chairmanship of J. J. MacKinney, is the first concerted effort to put down in concise form the correct and scientific definitions of the various terms used. It clearly explains and describes the different resistance-welding processes and explains them.

In a careful and orderly fashion, the authors outline the principle of resistance welding; they describe the various welding processes, and the different welding machines and apparatus used. They give the necessary welding symbols used, their experience as to the weldability of metals and alloys, and the precautions required in welding them. They include also discussions of weld quality and procedure specifications and qualifications together with inspection and testing methods. The text is well illustrated with electrical wiring diagrams and weld "setups."

In my opinion, the committee has done a fine job in assembling in such a clear, concise, and complete manner the knowledge necessary to an understanding of this important subject. To those engaged in the use of any resistance welding process, whether they be laymen or engineers, this book is absolutely essential.

Joseph Winlock

Plastics Progress 1955

P. Morgan, Ed.; Philosophical Library, New York, N. Y.; 432 pp.; $17.50.

This book contains the full report of the third British Plastics Convention held in June, 1955. The 20 papers presented at the Convention have been edited, but the discussions which follow each group of papers are transcripts and maintain the informal style as recorded.

The papers are grouped under the following headings: Polymer Structure and Properties, Expanded Plastics, Thermoplastics, Extrusion, Work Study and Productivity, Injection Moulding, Patents, Foundry Resins, and Glass Reinforced Plastics.

The preface states that some of the papers include the results of original investigations for which this book provides the first publication. The papers on "Fundamental Problems of Single-Screw Thermoplastic Extruders" by E. Gaspar, "The Effect of Injection Moulding Variables on the Quality of Mouldings" by K. C. Bryant and G. Hulse, and "Recent Advances in Injection Moulding Techniques and in the Evaluation of Moulding Materials" by G. Campbell and L. L. Griffiths, appear to fall into this category. However, few if any of the papers are of the "review" type which might be suggested by the title of the book. Instead they are all specific, informative, and thought provoking. Proof of this is found in the discussions which fill almost 25 per cent of this 400-page book. These demonstrate that those who attended this Plastics Convention in Great Britain were highly intelligent, articulate, and serious scientists and technologists.

The papers themselves indicate that much good work is being done. It is somewhat regrettable that original work should be reported in a relatively expensive book rather than in a technical journal of wider circulation.

J. E. Hanna

Mechanical Vibrations

J. P. Den Hartog; McGraw-Hill Book Co., Inc., New York; 4th ed.; 436 pp.; $9.

Vibration, the knowledge of which is now a very definite part of the mechanical engineer's stock in trade, not too long ago was missing from the curriculum of our technical schools. Its introduction in the early thirties and its subsequent establishment as a required study for the mechanical engineer is due in large measure to the work of Den Hartog in providing a basic text on this subject in 1934. The continuing usefulness of this book, both the original and later editions, is well demonstrated over the years by its wide acceptance both as a textbook and as a reference for practicing engineers.

In keeping with the expanding art and science of engineering, the subject of vibration has grown apace, and where once Den Hartog's book covered the entire then known field of vibration, such cannot be said for it now. This is no criticism of the present edition, for in order to keep the book to a reasonable size as a basic text and reference, it was necessary to omit detailed treatment of electrical measuring instruments, servomechanisms, and aircraft flutter theory—all of which are now regarded as separate studies represented by large bodies of literature.

Vibration theory is made all the more understandable and usable through the numerous practical problems included in every chapter. Examples are given for floating power in automobiles, shock absorbers, crank-shaft oscillation, propeller damping, vibrations in rotating machinery, airplane wing flutter, and wheel shimmy, as well as many others. Mathematical treatment is adequate but, as the author points out, the simplest approach available has been chosen in all cases.

This is a book that both the engineering student and the practicing engineer can use to advantage.

F. Y. S.

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News items concerning the activities of our members will be welcomed for inclusion in this column

NOTE—These "Personals" are arranged in order of alphabetical sequence of the names. Frequently two or more members may be referred to in the same note, in which case the first one named is used as a key letter. It is believed that this arrangement will facilitate reference to the news about members.

Many ASTM members were honored by the American Society of Civil Engineers at its Annual Convention in Pittsburgh in October. ASCE honorary membership was presented to **Albert Haertlein,** who has devoted his life to the teaching of Civil Engineering at Harvard University; also to **Ole Singstad,** member of the consulting firm of Singstad & Baillie, New York City, who for more than forty years has been a leader in tunnel design, construction, and operation. **Fred Burggraf,** associate director, Highway Research Board, Washington, D. C., and **Chester P. Siess,** research associate professor in civil engineering, University of Illinois, received 1956 ASCE Research Prizes—the citation for Mr. Burggraf reading "in recognition of outstanding contributions to knowledge through the administration of research in highway engineering and construction materials"; Professor Siess was recognized for "outstanding contributions to knowledge through his research on reinforced concrete slabs." **Robert Horonjeff** was co-winner with John Hugh Jones (both of the University of California Institute of Transportation and Traffic Engineering) of the Arthur M. Wellington Prize for paper "Determination of Radii of Curvature of Taxiways." **Jonathon Jones,** chief engineer of fabricated steel construction, Bethlehem Steel Co., received the Thomas Fitch Rowland Prize for his paper "Erection of Main River Span, Passaic River Bridge." **Frank E. Richart, Jr.,** professor of civil engineering, University of Florida, was co-winner with Allen J. Curtis (with Hughes Aircraft Co., also lecturer at University of California) of the Middlebrooks Award for paper "Photoelastic Analogy for Non-Homogeneous Foundations." **Lawrence T. Wyly,** professor of Civil Engineering, Northwestern University, with two collaborators, received the J. James Cross Medal for his paper "Fatigue in Riveted and Bolted Single-Lap Joints." **Clinton D. Hanover, Jr.,** of the New York City consulting firm of Hardesty & Hanover, chiefly concerned with design and construction of bridges, was inducted as director for ASCE District 1. **Howard F. Peckworth,** managing director, American Concrete Pipe Assn., was inducted as director for District 8.

A number of ASTM members were honored at the meeting of the American Society for Metals in Cleveland in October. **Donald S. Clark,** professor of mechanical engineering, California Institute of Technology, Pasadena, was nominated as ASM president for 1956–57. **George M. Young,** technical director, Aluminum Co. of Canada, Ltd., Montreal, became vice-president of the Society. **C. H. Lorig,** assistant director, Battelle Memorial Inst., Columbus, Ohio, continues as treasurer; and **William H. Eisenman,** ASM National Headquarters, Cleveland, as secretary. **Edgar H. Dix,** assistant director of research at the Aluminum Co. of America's Aluminum Research Laboratories, Pittsburgh, received the coveted Albert Sauveur Achievement Award for outstanding work in aluminum alloys research. **Mr. Eisenman,** for more than 39 years ASM national secretary, was chosen by the Society trustees for the ASM Gold Medal, being described by them as a man "who advanced metallurgy from an art to a science" while helping build the Society to its present membership of over 27,000 members in 100 chapters around the world.

New appointments to the board of trustees include **A. O. Schaefer,** director of research, Midvale-Heppenstall Co., Philadelphia, Pa., retiring president, and **Carl E. Swartz,** consulting metallurgist, Hinsdale, Ill.

Arthur J. Abrams, formerly with Secón Metals Corp., White Plains, N. Y., is now metallurgist, Handy & Harman, Inc., Bridgeport, Conn.

Frank J. Anderson is now assistant plant manager, Dragon Cement Co., Inc., Northampton, Pa.

A. Griffin Ashcroft, for many years vice-president and director of research and development of Alexander Smith & Sons, Inc., recently joined the staff of Arthur D. Little, Inc., consulting research company of Cambridge, Mass. With this move Mr. Ashcroft goes from former concentrated activities in the textile industrial research field into the broad area of consulting services in research and development in all branches of industry and science represented by the Little organization of over 800 scientists, engineers, and technical assistants. He will be in the New York City office (Graybar Building). A past ASTM director and very active in the work of Committee D-13 on Textile Materials for more than 20 years, Mr. Ashcroft is well known to many ASTM members as well as to the Headquarters Staff.

Joseph J. Benischek, formerly with Fred Whitaker Co., Philadelphia, Pa., is now with Philadelphia Wool Scouring and Carbonizing Co., in the capacity of chemist.

Andrew R. Blanck, until recently with Celanese Corp. of America, Chemical Div., Summit, N. J., is now with the Polymer Chemicals Div., W. R. Grace & Co., as chief chemist at the new applications research and technical service laboratories in Clifton, N. J. In accordance with his responsibilities for the chemical and electrical groups, he is active on various subcommittees and task groups of Committee D-9 on Electrical Insulating Materials and is maintaining contact with Committee D-20 on Plastics.

Charles W. Briggs addressed the 23rd International Foundry Congress held in Düsseldorf, Germany, September 6. He spoke on Green Sand Molding of Large Steel Castings. A recognized authority in the field of steel castings, Mr. Briggs has been technical and research director of the Steel Founders' Society of America since 1938 and consultant at the Naval Research Laboratory, Washington, D. C.

Kenneth R. Brown, vice-president and director of Atlas Powder Co., Wilmington, Del., retired September 1 after 38 years with the company.

Walter Brown, formerly with The Brewster Co., Inc., Shreveport, La., is now chief engineer, Paramount Textile Machinery Co., Angola, Ind.

Charles S. Chisolm has been named general superintendent of the foundry division, The Wheland Co., Chattanooga, Tenn.

Martin B. Chittick of the American Mineral Spirits Co., Murray Hill, N. J., received the Achievement Award of the National Lubricating Grease Inst., in recognition of outstanding services in the development of the lubricating grease classification system, now the International Standard Method of Classification.

W. Howard Corddry, vice-president and chief engineer of Gannett, Fleming, Corddry, and Carpenter, Inc., Harrisburg, Pa., was awarded an alumni citation at Washington College. Mr. Corddry worked on the study of the water resources of the Delaware River Basin which New York would tap as a source of water supply.

Morton Cotlar, formerly with Sunshine Scientific Instrument, Philadelphia, is now senior project engineer, Sperry Gyroscope Div., Sperry-Rand Corp., Plainview, N. Y.

Clyde A. Crowley, until recently director of development, engineering and research division, Given Manufacturing Co., Los Angeles, Calif., is now on the faculty of Arizona State College, Department of Chemistry.

Harold J. Dawe, for more than a decade in charge of research and development at Acheson Colloids Co., Port Huron, Mich., has been appointed technical staff con-

(Continued on page 72)

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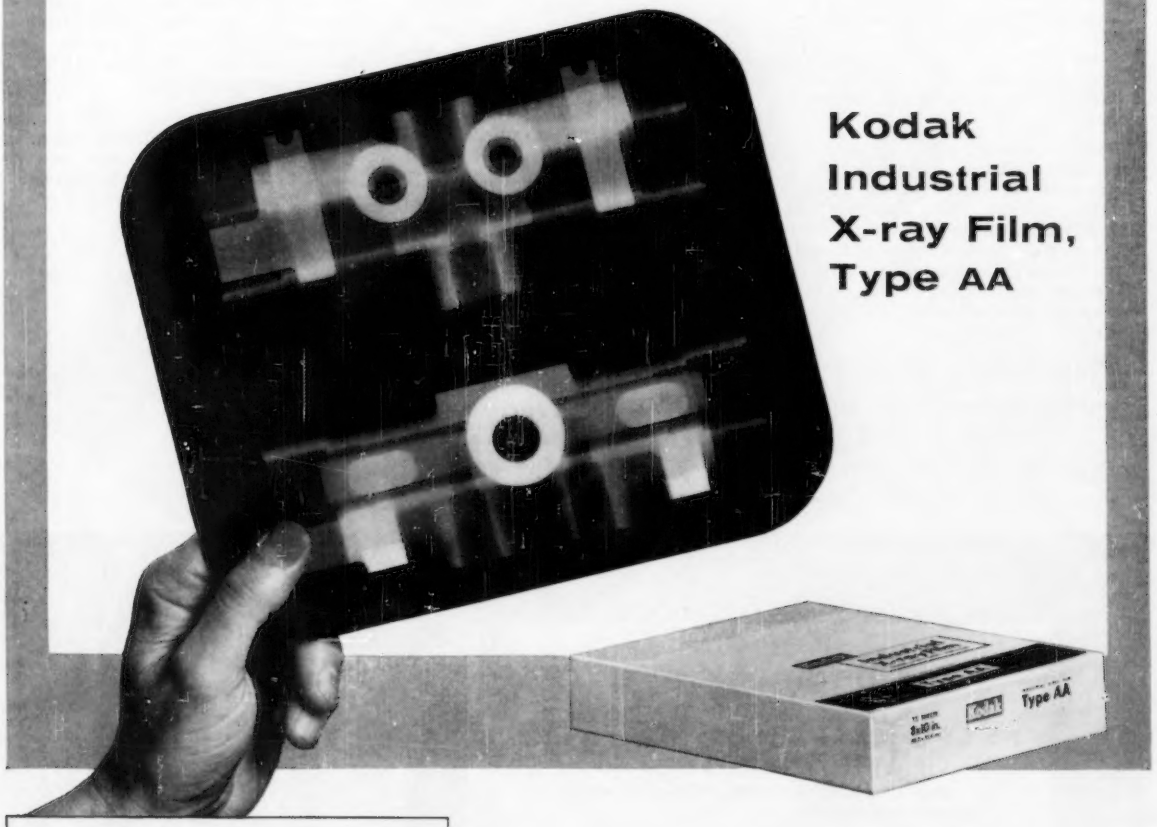

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Personals

(*Continued from page 67*)

sultant of Acheson Industries, Inc. Dr. Dawe's new responsibilities will include supervision of technical activities at all seven Acheson Industries plants located in the United States, England, and Holland. He will maintain headquarters at Port Huron.

Dominic D'Eustachio, Pittsburgh Corning Corp., Pittsburgh, Pa., has been nominated to serve for three years on the Committee on Research of the American Society of Heating and Air-Conditioning Engineers.

Harry W. Dietert, vice-president of the American Foundrymen's Society and chairman of the board of Harry W. Dietert Co., Detroit, Mich., presented the AFS official exchange paper at the 23rd International Foundry Congress in Düsseldorf, Germany, in September. Title of his paper was "Elevated Temperature Testing and Its Correlation with Casting Defects."

Thomas G. Digges, well-known metallurgist, has been appointed assistant chief of the Metallurgy Division of the National Bureau of Standards, Washington, D. C. A member of the Division for 36 years and acting assistant chief since 1950, Mr. Digges will continue to help direct the Bureau's diversified program of metallurgical research and development. He also will remain chief of the Thermal Metallurgy Section.

Richard S. Dill, chief of the Heating and Air Conditioning Section, National Bureau of Standards, has been nominated for a three-year term on the Council of the American Society of Heating and Air-Conditioning Engineers.

J. Morley English was appointed to organize Harvey Aluminum Structures, division of Harvey Machine Co. Inc. The new division of the Torrance, Calif., company will engineer, fabricate, and erect aluminum structures.

ASTM past-director **Edgar W. Fasig** has been elected vice-president, manufacturing, technical and production operations, The Lowe Bros. Co., Dayton, Ohio. Very active for many years in ASTM Committee D-1 on Paint, Varnish, Lacquer, and Related Products, Mr. Fasig currently serves as vice-chairman of the D-1 main group, and heads its Advisory Committee and Inter-Committee Relations group.

Harry L. Fisher retired as professor of chemical engineering, University of Southern California and director of the Tlargi Rubber Technology Foundation. This is his second retirement. He joined the Southern California faculty at 68 after retiring as director of organic research at U. S. Industrial Chemicals, Inc., Stamford, Conn.

Alfred M. Freudenthal, professor of civil engineering at Columbia University, was awarded the 1956 Medal of the Swedish Aeronautical Society. Presentation was made at the Swedish Institute in Stockholm. Dr. Freudenthal practiced engineering in Europe and the Near East for 26 years, and in 1948 joined Columbia faculty as a special lecturer.

Milton A. Glaser, vice-president and technical director of Midland Industrial Finishes, Waukegan, Ill., has been installed as 35th president of the Federation of Paint and Varnish Production Clubs.

Robert D. Grant, formerly with Boyle Engineering Co., Santa Ana, Calif., is now design engineer, Ralph M. Parsons Co., Los Angeles.

William J. Grede, president, Grede Foundries, Inc., Milwaukee, Wis., was elected chairman of the executive committee, J. I. Case Co., Racine, Wis. He has been a director of J. I. Case Co. since 1953.

(*Continued on page 74*)

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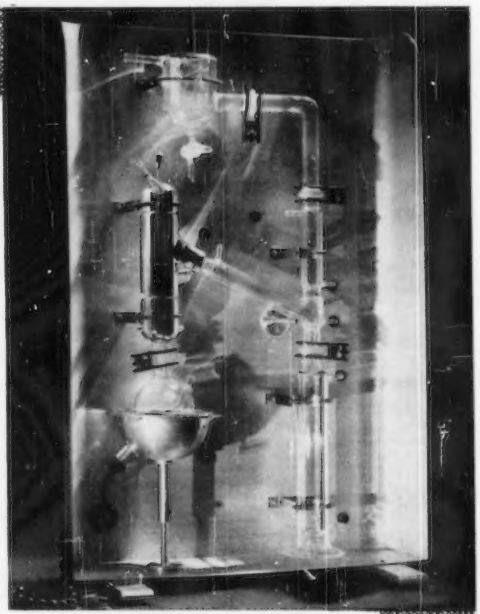

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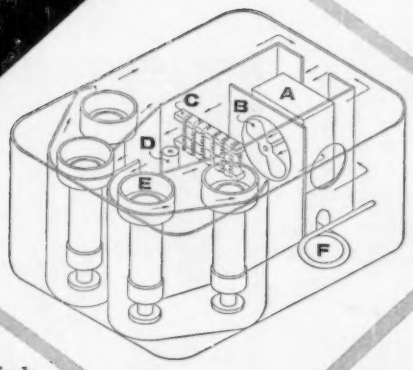

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Personals

(*Continued from page 72*)

H. Thomas Hallowell, Jr., president, Standard Pressed Steel Co., Jenkintown, Pa., was re-elected president of the American Standards Assn., New York City. **T. E. Veltfort,** manager, Copper & Brass Research Assn., New York City, was re-elected vice-chairman of the Council.

James C. Hodge, vice-president, was elected executive vice-president of Warner & Swasey Co., Cleveland, Ohio. Formerly president of Wellman Engineering Co., he joined W&S in January.

Arthur V. Hughes has been named vice-president and director of engineering, Kuhlman Electric Co., Bay City, Mich. He joined Kuhlman in 1951 as director of engineering.

G. E. Hutchinson fills the new post of quality control manager at Rem-Cru Titanium, Inc., Midland, Pa. Former assistant sales manager, he was in charge of process engineering and control in the production department, 1951 to 1954.

Clyde B. Jenni, chief metallurgist, General Steel Castings Co., Eddystone, Pa., has been appointed chief of the Castings Branch, Iron and Steel Div., Business and Defense Services Administration, Washington, D. C. On loan from General Steel Castings, with whom he has been associated since 1938, he will serve in the Washington post for about six months. He can be reached there at STerling 3-9200, Ext. 2279 (office, 4228 Commerce Building). Widely known in the steel castings industry and active in many technical groups, Mr. Jenni currently heads Subcommittee VIII on Steel Castings of ASTM Committee A-1 on Steel.

W. G. Kemmerer retired September 1 as engineer of bridges and buildings, The Pennsylvania Railroad Co. Mr. Kemmerer resides at 508 Rockavon Rd., Narberth, Pa.

Monroe H. Kessler is assistant vice-president, Weirton Steel Co., Weirton, Va. He was formerly assistant chief metallurgist.

Charles F. Kettering, director and research consultant of General Motors Corp., was named the industrialist of the year by the Society of Industrial Realtors. He received the 1956 Industrial Award Trophy, November 14, in St. Louis.

Stewart H. Kilmer has been appointed works manager, Ambridge, Pa. plant, Spang-Chalfant Div., National Supply Co., Pittsburgh, Pa.

Augustus B. Kinzel, vice-president of research for Union Carbide and Carbon Corp., New York City, has been elected president of the American Institute of Mining, Metallurgical, and Petroleum Engineers for one year beginning February, 1958. Among others elected to take office in 1958 is **James S. Vanick**, research metallurgist, International Nickel Co., New York City, to serve as director for three years. Both Messrs. Kinzel and Vanick have long been active in the work of ASTM.

A. L. Kuehn has retired as president of American Creosoting Co., Louisville, Ky. He plans to continue his ASTM affiliation, held since 1914. He served for many years on Committee D-7 on Wood and several subgroups. Mr. Kuehn resides at 220 S. Ridgeland Ave., Oak Park, Ill.

Joakim G. Laguros, formerly on the faculty of Iowa State College, Ames, is now assistant professor of civil engineering, Robert College, Bebek, Istanbul, Turkey.

A. J. Langhammer recently retired after 30 years with Chrysler Corp., Detroit, Mich., most of them spent in charge of the

(*Continued on page 76*)

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Personals

(*Continued from page 74*)

Amplex Division. His principal task with Amplex has been to perfect bearings and other parts made of powder metals. The quality of his work in powder metallurgy brought him the Achievement Medal of Stevens Institute of Technology in 1948. In ASTM, Mr. Langhammer served for many years on Committee B-9 on Metal Powders and Metal Powder Products.

J. A. MacLeod, formerly with Bechtel Corp., Vernon, Calif., is now utilities supervisor, International Petroleum (Colombia), Cartagena, Colombia.

Robert H. Madden, Jr., has been named manager, metallurgy, inspection and research, Tennessee Coal & Iron Div., U. S. Steel Corp., Birmingham, Ala.

William Mahin, consulting engineer on research and development problems, Cambridge, Ohio, has been named executive secretary of the Committee on Manpower for the Metallurgy and Ceramics Professions, sponsored by leading engineering educators.

J. L. McCloud, who recently retired as staff consultant at Ford Motor Co.'s manufacturing engineering office, has been named consulting editor of *Metal Progress.*

Francis T. McGuire has been promoted to the position of works manager of the John Deere Harvester Works of Deere & Co. Since 1949 he has been manager of the company's materials engineering department in Moline, Ill.

Past-President **N. L. Mochel,** manager of metallurgical engineering for the Steam Division, Westinghouse Electric Corp., Philadelphia, Pa., has been appointed a member of the committee on Science and the Arts by the Board of Managers of the Franklin Institute, Philadelphia. The committee has been in existence for over 100 years to evaluate scientific progress throughout the world in all fields of scientific endeavor. Selected scientists found worthy of recognition are recommended for awards through the Institute.

Don O. Noel, formerly with The General Metals Powder Co., Akron, Ohio, is now assistant to president, Metals Disintegrating Co., Elizabeth, N. J.

I. A. Oehler was elected vice-president of operations, American Welding & Mfg. Co., Warren, Ohio. Formerly administrative assistant, Dr. Oehler became manager of manufacturing last year.

Robert E. Payne has been named director of research for the Sharples Corp., centrifugal and process engineers, Philadelphia, Pa. He also will serve as technical advisor on production for the company

Elmer R. Queer, director and professor of engineering research, The Pennsylvania State University, has been nominated for first vice-president of the American Society of Heating and Air-Conditioning Engineers.

Harry E. Rapp, formerly with The Lubri-Zol Corp., Cleveland, Ohio, is now with Benjamin Foster Co. Philadelphia, Pa.

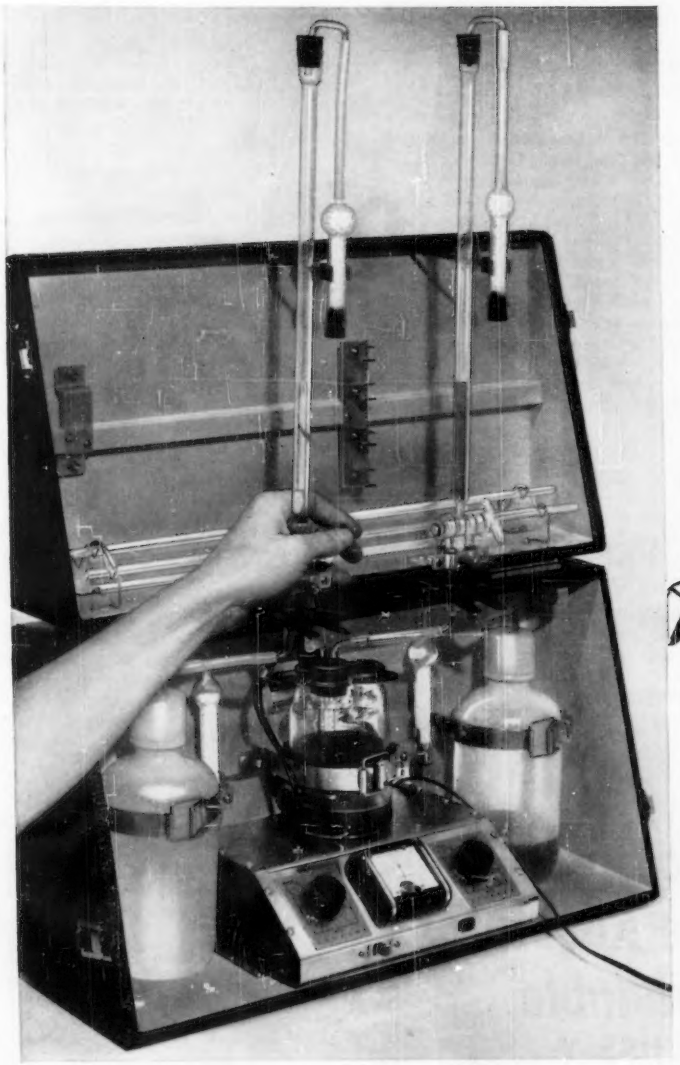
H. A. Reichenbach recently retired as vice-president, Nazareth Cement Co., Nazareth, Pa.

Percy L. Rogers has been elected vice-president in charge of research and quality control, Riverton Lime and Stone Co., Riverton, Va. He joined the company in 1932 as plant chemist.

William T. Savage, until recently supervisor, materials engineering, Armour Research Foundation, Chicago, Ill., is now supervisor, construction systems research, United States Gypsum Co., in the same city.

Alfred Schneider has accepted a position as chemical engineer, Swiss Grinding

(*Continued on page 78*)



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Personals

(*Continued from page 76*)

Wheel Co., Ltd., Winterthur, Switzerland. He was formerly chief chemist, St. Lawrence Cement Co., Quebec, Canada.

Peter V. Schneider has been appointed staff metallurgist in product engineering at the International Business Machines Corp.'s Product Development Laboratory in Endicott, N. Y.

Robert S. Shane has been promoted from supervisory engineer, Fuel Element Development Group, Reactor Engineering Dept., Westinghouse Commercial Atomic Power Activities, Pittsburgh, Pa., to the position of manager, Chemistry and Ceramics Section of the Reactor Engineering Dept.

John C. Smack, formerly with Sperry Products, Inc., Danbury, Conn., is now with Curtiss-Wright Corp., Industrial and Scientific Products Div., Caldwell, N. J.

Earle C. Smith has been appointed director of research, Republic Steel Corp., Cleveland, Ohio. He continues as chief metallurgist. Mr. Smith will supervise a new research laboratory soon to be constructed in Independence, Ohio.

Samuel Sidney Steinberg, dean of the University of Maryland's College of Engineering since 1936, becomes head of a government-operated aeronautical engineering school in Brazil this month. Professor Steinberg, who has been at Maryland University 38 years, calls his new school "the MIT of Brazil, with a distinguished faculty of professors from that country, North America, and other places." He plans to fly from New York December 27 to take his post at the Brazilian school—50 miles from Sao Paulo—which has grown to 500 students since its start in 1950.

Edwin V. Sumner, formerly with Federated Metals Div., American Smelting and Refining Co., Los Angeles, Calif., is now manager, Baker Metal Finishing Co., in the same city.

Verachai Suwunnakarn, of the engineering staff, Building Control Section, Municipality of Bangkok, Thailand, is a graduate student at the University of Texas at Austin.

Louis C. Thayer, formerly director of research, Arnold O. Beckman, Inc., Pasadena, Calif., is now vice-president of engineering, Skil Corp., Chicago, Ill.

David P. Thomas is president, Fort Scott Hydraulic Cement Co., Inc., succeeding the late Howard M. Thomas.

Lewis H. Tuthill, until recently with the Bureau of Reclamation, Denver, Colo., is now with the California State Dept. of Water Resources, Division of Design and Construction, Sacramento.

Maurice Van Loo, director of paint research, The Sherwin-Williams Co., Cleveland, Ohio, delivered the Joseph J. Mattiello Lecture in October at the Annual Meeting of the Federation of Paint and Varnish Product Clubs. A specialist in his field, Mr. Van Loo had close association with the late Mr. Mattiello in wartime activities.

John J. Vreeland, previously products control head and technical service metallurgist at the Cleveland, Ohio, mill of Chase Brass & Copper Co., has been named staff manager, sheet and strip, at the Waterbury, Conn., headquarters of the company. Since joining Chase in 1930 as a research engineer, Mr. Vreeland has served in several capacities in Waterbury and Ohio.

L. L. Whiteneck, formerly senior harbor engineer, Long Beach (Calif.) Harbor Dept., is now vice-president and director of corrosion control and material research, Plicoflex, Inc., Los Angeles, Calif.

Merritt A. Williamson has been named dean of the College of Engineering and Architecture, The Pennsylvania State University. He was previously director of research, Burroughs Corp., Research Center, Paoli, Pa.

Harold K. Work, director of the research division of the College of Engineering, New York University, recently received promotion, being named also professor of research management.

John J. Zutaut, formerly assistant technical adviser with Quartermaster Purchasing Center at Chicago Quartermaster Depot, is now on the technical staff of Technical Advisory Office with Quartermaster Purchasing Agency at Columbus (Ohio) General Depot, U. S. Army.

Through error, notes in the October 1956 "Personals" concerning Messrs. **Harold Allen** and **Earl F. Kelley** referred to the National Bureau of Standards. The affiliation reference should have been to the Bureau of Public Roads, U. S. Department of Commerce.

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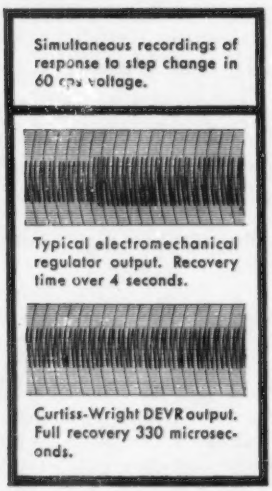
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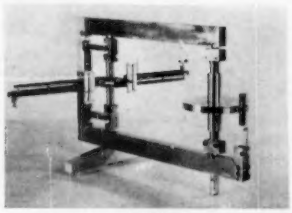
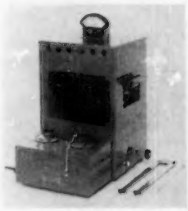


CS-28

ASTM D1433-56T

The Society of the Plastics Industry Flammability Tester measures the relative flammability hazard of various sheet materials from 0.001 to 0.250 inches, varying from very flammable to extremely flame-resistant. (Commercial standard 192-53)



CS-19

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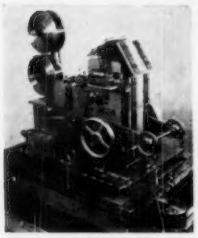

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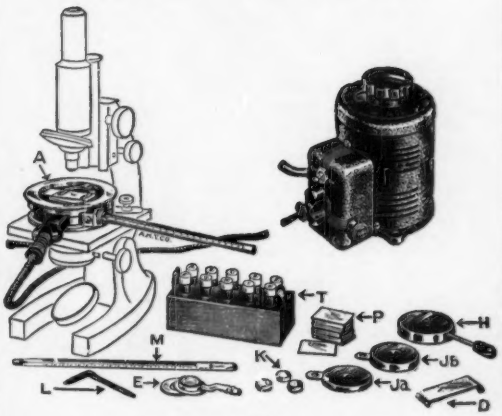

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NEW MEMBERS.....

The following 93 members were elected from September 19 to November 19, 1956, making the total membership 8632... Welcome to ASTM

Note—Names are arranged alphabetically—company members first, then individuals.—Your ASTM Yearbook shows the areas covered by the respective Districts.

CHICAGO DISTRICT (5)

Adams, Terrance, metallurgist, Perfex Corp., 500 W. Oklahoma Ave., Milwaukee 7, Wis. [A]*

Anderson, Marvin E., test engineer, American Steel Foundries, Hohman Ave. and Hoffman St., Hammond, Ind.

Bankard, Merrill H., president, Roxana Galvanizing Co., 5334 Indianapolis Blvd., East Chicago, Ind.

Fuerst, William R., sales engineer, Soil Test, Inc., 4711 W. North Ave., Chicago 39, Ill. [A]

Harloff, Robert E., instructor in engineering mechanics, Marquette University, Engineering College, 1515 W. Wisconsin Ave., Milwaukee 3, Wis.

Lynch, Eugene D., associate professor of ceramic engineering, University of Illinois, Department of Ceramic Engineering, 204 Ceramics Bldg., Urbana, Ill.

Markley, Harry S., partner, The Markley Laboratories, 312 Fourth Ave., S., Minneapolis 15, Minn. [A]

Murdock, John W., instructor in theoretical and applied mechanics, University of Illinois, Urbana, Ill. For mail: 1107 W. Green, Apt. 633, Urbana, Ill.

Rotariu, George J., technical director, Inland Testing Laboratories, 1457 Diversey Pkwy., Chicago 14, Ill.

Voros, Louis W., chief chemist, Testing Service Corp., 710 N. Brookfield St., South Bend, Ind. For mail: RR2, Box 108, South Bend, Ind. [A]

CLEVELAND DISTRICT (4)

Warren Refining and Chemical Co., The, Ian L. Carmichael, president, 5151 Denison Ave., Cleveland 2, Ohio.

Kramer, Edward R., chief engineer, David Round and Son, Inc., Box 883, Cleveland 22, Ohio. For mail: 1411 Lander Rd., Cleveland 24, Ohio.

Tissot, Robert A., secretary and treasurer, Maintenance Inc., Box 35, Wooster, Ohio.

DETROIT DISTRICT (6)

Belyea, Donald McClellan, engineering consultant, 2004 10th St., Port Huron, Mich. For mail: 721 Jenkinson St., Port Huron, Mich.

NEW ENGLAND DISTRICT (13)

Harrington & Richardson, Inc., Philip F. Sullivan, metallurgist, 320 Park Ave., Worcester, Mass.

Kaman Aircraft Corp., The, Frank M. Lister, chief metallurgist, Old Windsor Rd., Bloomfield, Conn.

San-Vel Contracting Co., Adelard A. Roy, president, Ayer Rd., Littleton, Mass.

Raytheon Mfg. Co., George J. Foundas, reliability coordinator, Missile systems Div., Box 87, Maynard, Mass.

Leong, Sing, laboratory director, MKM Knitting Mills, Inc., Manchester, N. H.

NEW YORK DISTRICT (1)

Fairchild Engine Div., Fairchild Engine and Airplane Corp., C. E. Carrigan, chief, Materials Lab., Deer Park, L. I., N. Y.

Filtors, Inc., B. Lazich, director of research and development, 30 Sagamore Hill Dr., Port Washington, N. Y.

Singer Manufacturing Co., The, C. R. Odermann, chief experimental engineer, 915 Pembroke St., Bridgeport 8, Conn.

Barker, C. S., chief metallurgist, Norma-Hoffmann Bearings Corp., Stamford, Conn.

Blank, Charles A., staff chemist, International Business Machines Corp., Airborne Computer Lab., Vestal, N. Y.

Brooks, Gregory E., chief of structural design, Voorhees, Walker, Smith & Smith, 101 Park Ave., New York 17, N. Y.

Davidson, James R., executive secretary, Society of Plastics Engineers, Inc., 34 E. Putnam Ave., Greenwich, Conn.

Day, Roger O., metallurgical engineer, Linde Air Products Co., 686 Frelinghuysen Ave., Newark 5, N. J.

Deimel, Erwin O., product design engineer, General Electric Co., LMEED, French Rd., Utica, N. Y.

Eckhardt, George R., manager of research, Coats & Clark, Inc., 1292 McCarter Highway, Newark 4, N. J.

Franks, Russell, manager, marketing research division, Electro Metallurgical Co., 30 E. 42nd St., New York 17, N. Y. For mail: 100 E. 42nd St., Room 1424, New York 17, N. Y.

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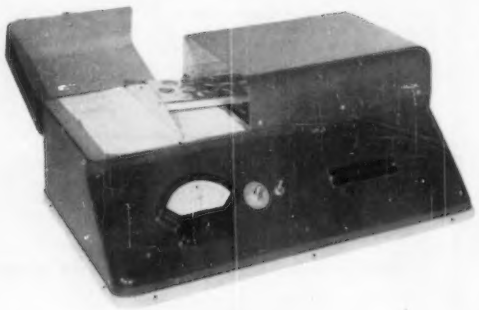

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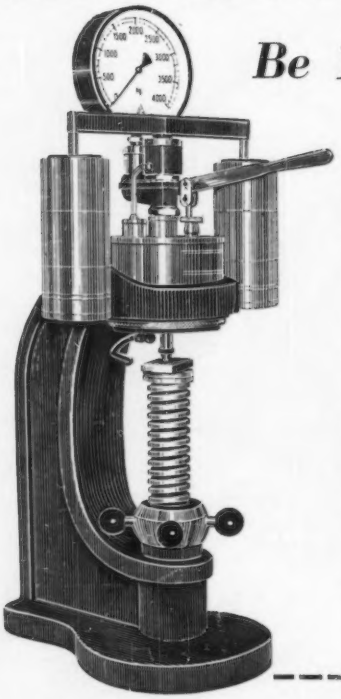

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New Members

(*Continued from page 80*)

Gunn, J. W., chief supervising chemist, Lone Star Cement Corp., 100 Park Ave., New York 17, N. Y.

Hoadley, Anthony, professor of civil engineering, Union College, General Engineering Bldg., Schenectady 8, N. Y.

Mullarkey, Edward J., technical director, Lead Industries Assn., 60 E. 42nd St., New York 17, N. Y. [A]

Noll, Joseph K., vice-president, Schwab Brothers Corp., 102 Maiden Lane, New York 5, N. Y.

Okerson, William E., engineer, New Jersey Bell Telephone Co., Room 1000, 540 Broad St., Newark 1, N. J. [A]

NORTHERN CALIFORNIA DISTRICT (8)

Rogers Engineering Co., Inc., H. Rogers, Jr., president, 16 Beale St., San Francisco 5, Calif.

California State Department of Water Resources, Walter G. Schulz, chief engineer, Devision of Design and Construction, Box 1079, Sacramento 5, Calif.

Kinzie, Robert A., Jr., plant manager, Pacific Coast Aggregates, Inc., 400 Alabama St., San Francisco, Calif. For mail: 433 Van Ness Ave., Santa Cruz, Calif.

Weber, William G., Jr., assistant physical testing engineer, California Division of Highways, Sacramento 14, Calif. For mail: 1409½ 16th St., Sacramento 14, Calif.

OHIO VALLEY DISTRICT (15)

Charlesworth, William H., engineer, General Research Dept., Perfect Circle Corp., Hagerstown, Ind. For mail: 1131 Webster Ave., New Castle, Ind.

Myers, Orval C., electrical engineer, John A. Richley, Sr. and Associates, 1334 E. 141st St., E. Cleveland 12, Ohio. For mail: 2659 Woodland Ave., Columbus 11, Ohio.

PHILADELPHIA DISTRICT (2)

Denny Paper and Board Co., Maurice Denenberg, president, 2028 Washington Ave., Philadelphia 48, Pa.

Belden, Arthur B., district sales manager, Universal-Cyclops Steel Corp., Bridgeville, Pa. For mail: Suburban Square Bldg., Ardmore, Pa.

Coogan, E. W., sales manager, Waverly Petroleum Products Co., 1724 Chestnut St., Philadelphia 3, Pa.

Coornvelt, Harlan, consulting engineer, Room 1415, 1201 Chestnut St., Philadelphia 7, Pa.

Harbeson, John F., partner, Harbeson, Hough, Livingston & Larson, 1510 Architects Bldg., Philadelphia 3, Pa.

Hudson, Samuel T., engineer, J. E. Brenneman Co., 121 S. Broad St., Philadelphia 7, Pa.

McAlister, Robert L., engineer, American Meter Co., Inc., 13500 Philmont Ave., Philadelphia 16, Pa.

Moore, Charles B., associate editor, *The Iron Age*, Chilton Co., 56th and Chestnut Sts., Philadelphia 39, Pa. For mail: 263 S. 21st St., Philadelphia, Pa. [A]

Pennsylvania, Commonwealth of, Department of Labor and Industry, Division of Bedding and Upholstery, John P. O'Neill, chief, Division of Bedding and Upholstery, 504 Feller Bldg., Harrisburg, Pa.

Schweider, Arnold, president, Allan Yarn Mills, Inc., Lenni Mills, Pa. For mail: 6913 Cherokee St., Philadelphia 19, Pa.

Slosberg, David K., chief chemist, Bonafide Plastics, Inc., 1945 E. State St., Trenton, N. J.

PITTSBURGH DISTRICT (3)

Hollenback, Elliott H., chief metallurgist, Bethlehem Steel Co., Johnstown Plant, Johnstown, Pa.

Kalson, H., research and development engineer, Blaw-Knox Co., Power Piping and Sprinkler Div., 829 Beaver Ave., Pittsburgh 33, Pa.

ST. LOUIS DISTRICT (9)

Alberga, Alvyn C., head engineer, Sverdrup & Parcel, Inc., 915 Olive St., St. Louis, Mo. For mail: 9606 Sappington Rd., St. Louis 23, Mo.

Friberg, Bengt F., consulting engineer, Room 1017, 915 Olive St., St. Louis 1, Mo.

Granite City Engineer Depot, U. S. Department of the Army, Engineer Packaging Technical Office, George E. Moore, acting chief, EPTO, Granite City, Ill.

SOUTHERN CALIFORNIA DISTRICT (7)

Amon, William F., Jr., associate director of research and development, Narmco, Inc., 1882 Moore St., San Diego 1, Calif.

Bass, John S., civil engineer, Los Angeles County Road Dept., 108 W. 2nd St., Los Angeles, Calif.

Bassett, James R., technical supervisor, The American Brass Co., Box 217, Paramount, Calif.

Eldridge, J. W., president, Dow-Elco, Inc., 1313 W. Olympic Blvd., Montebello, Calif.

Fredericks, Carl K., associate director of research and development, engineering, Narmco, Inc., 1882 Moore St., San Diego 1, Calif.

Moser, Ray E., sales manager, Adolf Frese Corp., 116 W. 17th St., Los Angeles 15, Calif.

(*Continued on page 84*)

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New Members

(Continued from page 82)

Richards, Carrol Arnold, testing engineer, Raymond G. Osborne Laboratories, Inc., 110 W. 9th St., Los Angeles 15, Calif. For mail: 1034 Palm Ave., S. Pasadena, Calif.

Rust, Quentin, owner, Rust Concrete Research and Development, Inc., 143 N. Commonwealth Ave., Los Angeles 4, Calif.

Steinhardt, Lawrence R., general manager, Narmco Metlbond Co., 600 Victoria St., Costa Mesa, Calif.

VanVeen, Peter J., assistant engineer, Livingston Rock and Gravel Co., Inc., 3366 Cherry Ave., Long Beach 7, Calif.

SOUTHWEST DISTRICT (16)

Dahl, George L., Architects and Engineers, H. T. J. Martin, 2101 N. St. Paul St., Dallas 1, Tex.

Lindveit, G. M., senior design engineer, The Dow Chemical Co., Freeport, Tex. For mail: 504 Winding Way, Lake Jackson, Tex.

Reid, R. L., owner, R. L. Reid, Inc., 2506 Richton, Houston 6, Tex.

Wildes, Leland A., manager, Ore Research and Laboratories, Inc., 1511 Levee St., Dallas 7, Tex.

WASHINGTON (D. C.) DISTRICT (14)

Associated General Contractors of America, Inc., The, James D. Marshall, executive director, 1227 Munsey Bldg., Washington 4, D. C.

Maton, Gilbert L., vice-president, John I. Thompson and Co., 921 17th St., N. W., Washington 6, D. C.

Schnabel, James Joseph, general manager, Foundation Test Service, Inc., 1605 Kennedy Pl., N. W., Washington 11, D. C. [A]

Wells, John D., III, sales engineer, Carolina Fly Ash, Inc., 205 S. Church St., Charlotte 2, N. C. For mail: 303 Capital Apts., Charlotte 2, N. C.

WESTERN NEW YORK-ONTARIO DISTRICT (10)

Orenda Engines, Ltd., E. K. Booth, chief, metallurgical services, Box 4015 Terminal "A," Toronto, Ont., Canada.

Stikker, A., chief chemist, St. Lawrence Cement Co., Box 520, Clarkson, Ont., Canada. [A]

UNITED STATES AND POSSESSIONS

Georgia Duck and Cordage Mill, Charles R. Bradford, assistant manager, Scottdale, Ga.

Utah Power and Light Co., H. Boehmer, chief engineer, Box 899, Salt Lake City 10, Utah.

Jenson, T. B., vice-president, Gee & Jenson, Consulting Engineers, Inc., 117½ S. Dixie, West Palm Beach, Fla.

Mortimore, D. M., laboratory manager, Oregon Metallurgical Corp., Box 311, Albany, Ore.

OTHER THAN U. S. POSSESSIONS

Industrias Kaiser Argentina, S. A., Calvin A. Johns, chief, materials engineering, Paseo Colon 439, Buenos Aires, Argentina.

Lorraine-Escaut, Dep Tubes, Usines d'Anzin, Anzin (Nord), France.

Aldis, Basil Carlyle, principal technical executive, The British Plastics Federation, 47/48 Piccadilly, London, S.W. 1, England.

Baker, George Stephen, technical assistant, Scottish Cables (S. A.), Ltd., Box 188, Pietermaritzburg, Natal, South Africa. [A]

Bustamante, Rene, director, Ingenieria y Diseno, S. A., Box 4645, Correos del Este Caracas, Venezuela.

Forrest, J. S., director, Central Electricity Research Laboratories, Randalls Farm Lane, Kingston Rd., Leatherhead, Surrey, England.

Fullard, Robert, senior technologist, James Stott, Ltd., Box 32, Oldham, Lancs., England.

Hasegawa, Taro, metallurgical engineer, Osaka Steel Works, Sumitomo Metal Industries, Shimaya-cho, Konchane-ku, Osaka, Japan.

Jones, Joseph E., materials and test engineer, International Cooperation Administration, Washington, D. C. For mail: American Embassy USOM/Honduras, Tegucigalpa, Honduras.

Nishiyama, Akira, president, ACME Inspection and Engineering Corp., No. 10, 1-Chome, Kojimachi, Chiyoda-ku, Tokyo, Japan. For mail: Box 418, Central Tokyo, No. 1335, Kichijoji, Musashinoshi, Tokyo, Japan.

Riessauw, F., professor, Magnel Laboratory for Reinforced Concrete, St. Pietersniewstraat 59, Ghent, Belgium.

Technion Research and Development Foundation, Ltd., Building Research Station, Department of Testing Materials, Israel Institute of Technology, Haifa, Israel.

Wright, J. O., general manager, The Hume Pipe Co. (South Africa), Ltd., Box 204, Germiston, South Africa.

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DEATHS...

William M. Camp, director of research, The Spool Cotton Co., Newark, N. J. (August 10, 1956). Member since 1939, and active in Committee D-13 on Textile Materials since 1943.

E. O. Dixon, vice-president in charge of research and metallurgy, Ladish Co., Cudahy, Wis. (November 4, 1956). Affiliated with the Society since 1937, Mr. Dixon had been very active in certain of the metals groups, including Committee A-1 on Steel and several subgroups, also Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys. He served too on the Joint ASTM-ASME Committee on Effect of Temperature on the Properties of Metals, Gas Turbine and Low-Temperature Panels.

John Lewis Eigenbrot, retired assistant to the president of the General Coal Co., with offices in the Fidelity-Philadelphia Trust Building, Philadelphia, Pa. (October 8, 1956). Mr. Eigenbrot had represented his company in the Society and on Committee D-5 on Coal and Coke for 15 years prior to his retirement in 1955.

Charles J. Emerson, president and treasurer, Emerson Apparatus Co., Melrose, Mass. (January 1, 1956). Member since 1920, and active for many years on Committees D-11 on Rubber and Rubber-Like Materials, and D-13 on Textile Materials.

Alexander Frieden, vice-president of research, Pabst Laboratories, Milwaukee, Wis. (April 21, 1956). Representative of company membership since 1950.

Shortridge Hardesty, a partner in the New York City consulting firm of Hardesty & Hanover, and internationally famous bridge designer, died at his home in Larchmont, N. Y., October 17, 1956, at the age of 72. An ASTM member since 1938, Mr. Hardesty had served on Committee A-1 on Steel and its Subcommittee II on Structural Steel for Bridges, Buildings, Rolling Stock and Ships since 1943; and on Subcommittee I on Iron and Steel Filler Metal of the Joint AWS-ASTM Committee on Filler Metal since 1944. A 1908 graduate in civil engineering from Rensselaer Polytechnic Inst., he had received three honorary degrees.

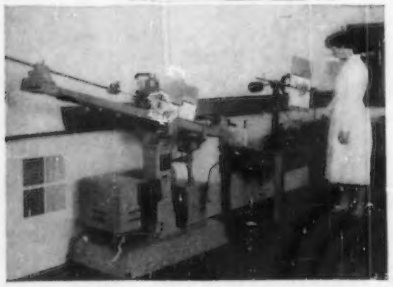
Gleason H. MacCullough, head, Department of Mechanical Engineering, Worcester Polytechnic Inst., Worcester, Mass. (October 15, 1956). Representative for many years of the WPI membership in ASTM.

Gustave Magnel, professor, Laboratory of Reinforced Concrete, University of Ghent, Ghent, Belgium (September, 1955). Member since 1950.

Roscoe H. Sawyer, retired technical director, Devoe & Raynolds, Louisville, Ky.; in earlier years associated with E. I. du Pont de Nemours & Co., Inc., and Krebs Pigment and Color Corp. (April 6, 1956). A personal member of the Society for many years, and for 21 years a very active and helpful member of ASTM Committee D-1 on Paint, Varnish, Lacquer, and Related Products, and many of its subgroups, Dr. Sawyer was directly responsible for the development of many of the specifications and test methods today in use in the paint industry. Since 1930 he had held positions of increasing importance and responsibility in the field of pigment and paint technology. His friends and associates in Committee D-1 especially will miss his presence at meetings and his helpful advice.

Howard McCutcheon Thomas, president and general manager, Fort Scott Hydraulic Cement Co., Fort Scott, Kans. (September 24, 1956). Personal member from 1924 to 1950, and representative of company membership for past six years.

-and in ENGLAND



Scott Testers at British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester, England.

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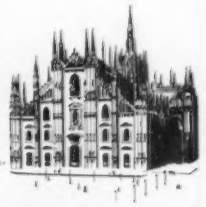

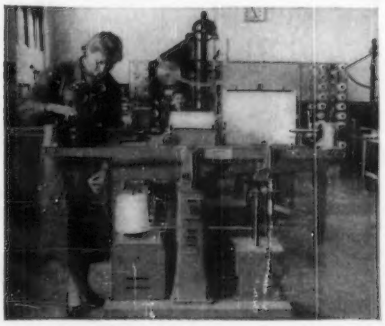

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NEWS NOTES ON
Laboratory Supplies and Testing Equipment

Note—This information is based on literature and statements from apparatus manufacturers and laboratory supply houses. The society is not responsible for statements advanced in this publication.

LABORATORY ITEMS

Recorder—Baldwin 50-point automatic scanning recorders for SR-4 strain gages have been improved. Include two-arm or four-arm strain gage bridges.
Baldwin-Lima-Hamilton Corp. 1242

Automatic High-Speed Centrifuge—Engineered with the objective of making high-speed laboratory separations as automatic and routine as possible, the new Spinco Model K Centrifuge claims a maximum speed of 25,000 rpm with forces of 50,000 times gravity on 160 ml of material.
Beckman Instruments, Inc. 1243

One-Third Octave Filter—Designed for sound and vibration analysis, measurement of sound transmission and reverberation time, and any audio signal analysis or telemetry data reduction.
Brush Electronics Co. 1244

Connectors—The devices avoid the conventional and time-consuming methods of making rubber and metal tubing connections and offer instead a means for easily making and breaking joints, adding and removing parts, and stopping or renewing the flow of gases, vapors, or liquids.
Burrell Corp. 1245

Moisture Determinator—Apparatus is completely self-contained, weighs only 22 lb and can analyze liquid, solid, and gaseous samples without removing them from the case.
Central Scientific Co. 1246

Low-Temperature Unit—New low-temperature chilling machine with a 4 cu ft chamber has just been developed.
Cincinnati Sub-Zero Products 1247

Chromatograph—New vapor phase chromatograph, specifically developed for use in research and analytical laboratories uses the elution method.
Consolidated Electrodynamics 1248

Spin Tester—Design and production of a new automated spin-test machine for cut-off saws and grinding wheels has been announced.
George L. Day Co. 1249

Asphalt Extractor—An apparatus for separating asphalt from bituminous concrete mixtures. Extraction is accomplished by gentle probing action of solvent vapors (rather than by centrifugal force) and is automatic.
Arthur J. Faulwetter 1250

Midget Infrared Oven—Inexpensive radiant heating units suitably designed for research and testing purposes.
Fostoria Pressed Steel Corp. 1251

High-Precision Timer—New, compact, and convenient Type 1213-C Calibrator comprises, with power supply and headphones, all the circuits necessary for the calibration of oscillators, receivers, and other wide-range devices up to frequencies above 1000 megacycles.
General Radio Co. 1252

Air Capacitor—Improvements in electrical and mechanical properties have been obtained in a variable air capacitor by machining them from solid metal.
General Radio Co. 1253

Stopcock Grease—New silicone-base grease is designed to resist leakage at elevated temperatures and prevent glass joints and stopcocks from freezing.
Glass Engineering Laboratories 1254

Surface-Finish Tester—Surface-finish testing and measuring instrument measures all standard surface-finish designations. The values, either in microns or microinches are computed electronically as the tracer scans the surface.
William J. Hacker & Co., Inc. 1255

Microtome Knife Sharpener—New microtome knife sharpener produces an edge suitable for any type of tissue cutting.
William J. Hacker & Co., Inc. 1256

X-Ray—130 Kv portable X-ray with tube head weighs 50 lb and is capable of penetrating up to 1¼ in. steel.
Holger Andreasen, Inc. 1257

Table Demineralizer—New model features direct faucet connection for deionized water on tap (ionically equivalent to distilled) with flow rates of better than 1 gal a minute claimed. A direct reading meter calibrated in ohms per cc and parts per million indicates the quality of water being delivered.
Ion Exchange Products 1258

Heater—Labline Speedy-Heet Duplex Heater, for ASTM petroleum tests and many other laboratory heating operations has been announced.
Labline, Inc. 1259

Viscosimeter—For running low-temperature viscosities; eliminates the usual use of dry ice and acetone mixtures.
Labline, Inc. 1260

Titrators—Three new sulfur titrators for use with the combustion-titration procedure for analyzing sulfur in steel, iron, oil, slag, ores, limestone, and a great variety of other materials, have been developed.
Laboratory Equipment Corp. 1261

Magnatest—New instrument automatically detects such problems as seams, overlapping, diameter changes, inclusions, voids, concentrated porosity, metallurgical variation, and splits. It is ideally suited for high-speed plant operation.
Magnaflux Corp. 1262

Electron Microscope—New 100 Kv electron microscope (Type EM-100B) with operating features includes a hinged objective lens for quick change or cleaning of pole inserts, magnetic compensator, objective diaphragm with multiple apertures, and insert screen with binoculars for ultra-thin specimens.
North American Philips Co., Inc. 1263

Recorder—Accurate, permanent records of time-settlement data from soil consolidation tests can be made automatically with the new K-W Autocon Recorder.
Tinius Olsen Testing Machine Co. 1264

Hardness Gage—A small hardness gage about the size of a fountain pen for use in measuring hardness of materials such as rubber and plastics has been announced.
W. F. Orth 1265

Thickness Gage—New portable electronic non-contact gage is now available for laboratories and quality control technicians to measure thickness of material in process.
Donald S. Routh 1266

Thermometer—A test instrument capable of full-scale indication on surface contact.
Royco Instruments 1267

Standard Spectra—To meet the requirements of a small, inexpensive spectrogram that has all the features of one's own spectra, the Midget Edition of the Sadtler Standard Spectra is now being introduced.
Sadtler Research Laboratories 1268

Double-Screw Drive Tester—Designed to test for tension, hysteresis, and compression within the range, 0–2000 lb tensile, the Model CET is a constant-rate-of-elongation tester with a broad range of speeds up to 40 in. per min, lengths of stroke up to 72 in., and infinitely variable loading between 0 and 2000 lb.
Scott Testers, Inc. 1269

Volumeasure—A new instrument for in-place density tests of soils is available. Rapid density tests of soils and similar materials can be made easily using the new Volumeasure.
Soiltest, Inc. 1270

X-Ray Spectrochemical Analysis—A set of eight low-alloy steels of the British Bureau of Analysed Samples has been specially prepared for X-ray spectrochemical analysis.
Spex Industries, Inc. 1271

(Continued on page 90)

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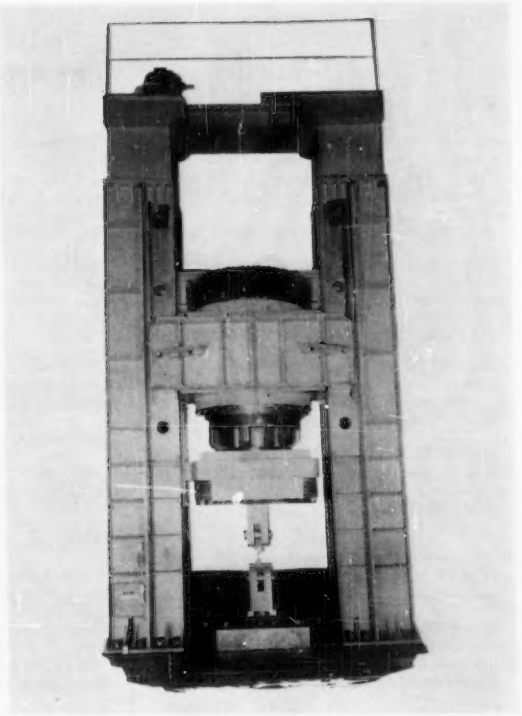

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(*Continued from page 88*)

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United Scientific Co. 1273

Enamel Rater—Can inspection tool for quality control in the packing and canning industry.
Wilkens-Anderson Co. 1274

20,000 lb Force Vibrator—New design will be applied to fatigue and other test equipment.
Wyle Mfg. Corp. 1275

CATALOGS AND LITERATURE

Glass Blowing—A 30-page illustrated manual describes modern glass blowing techniques including apparatus used.
Bethlehem Apparatus Co., Inc. 2149

Gas Chromatography—*Bulletin No. 831*, newly released 4-page brochure, describes the Burrell Kromo-Tog, Model K-3, for gas and vapor-phase chromatography in plant or laboratory.
Burrell Corp. 2150

Digital Technique—The art of using digital techniques for testing, information handling, and control is the subject of a 16-page booklet entitled, "Four Dimensions in Digital Design."
Burroughs Corp. 2151

Vacuum System—24-page booklet, *Bulletin No. 9*, provides a guide for the laboratory planning of the installation of a high vacuum system.
Central Scientific Co. 2152

Molybdenum Chemicals—New 4-page bulletin called, "A Guide to Sources and Applications of Molybdenum Chemicals" has been issued.
Climax Molybdenum Co. 2153

Spectroscope Catalog—New catalog describes various types of spectroscopes, such as diffraction, prism, reversion, and ultraviolet, and accessories.
The Ealing Corp. 2154

High-Speed Motion Pictures—Information about recent advances in film sensitivity which have extended the scope of high-speed movies for industry is included in "High Speed Motion Pictures at the Service of the Engineer."
Eastman Kodak Co. 2155

Price List—Includes a list of essential oils, aromatic chemicals, etc.
Fritzsche Brothers, Inc. 2156

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BURRELL *UNIT-PACKAGE*

Tube Furnaces

MODEL H-1-9 (pictured) For high temperature testing to 2650° F. For the determination of carbon and sulfur by combustion in ferrous metals. Available for one, two and four tubes. For use with 115 or 230 volts, 60 cycle, as specified.

For other models—Ask for Bulletin No. 310

CAT. NO.	ITEM	PRICE
24-934	One-Tube Furnace, Model H-1-9	675.00
24-944	Two-Tube Furnace, Model H-2-9	700.00
24-954	Four-Tube Furnace, Model H-4-9	1000.00

Prices listed are F.O.B. Pittsburgh, Pa.

EASY ACCESS PANELS FOR EASE OF SERVICING

All current models of Burrell furnaces open from the front for ease of inspection, parts replacement and servicing when necessary.

BURRELL CORPORATION
Scientific Instruments and Laboratory Supplies
2223 Fifth Avenue, Pittsburgh 19, Pennsylvania
CIRCLE 364 ON READER SERVICE CARD PAGE 105

Portable Glassware Washers—Data sheet describes new portable washer that cleans many different sizes and shapes of bottles, test tubes, flasks, burets, and other glassware.
Arthur S. LaPine & Co. 2157

Self-Balancing Scale—Data sheet describes self-balancing 5000-gr capacity scale that reads directly to 1 gr in 2 to 4 sec.
Arthur S. LaPine & Co. 2158

Millivolt Recorder—New four-page *Data Sheet E-ND46(6)* describing the complete line of Speedomax G Millivolt Recorders is now available.
Leeds & Northrup Co. 2159

Vibration—A six-page bulletin describing both vibration pickups and meters has just been published.
MB Mfg. Co. 2160

Automatic Color Difference Meter—*Data Sheet 10.10 6* describes color theory, accuracy and features of Gardner Automatic Color Difference Meter with Brown ElectroniK amplifier and motors. Meter gives three-part numerical comparison of color samples.
Minneapolis-Honeywell Regulator Co. 2161

Titanium Analysis—"Evaluating Titanium Alloys By X-ray Diffraction," the new literature is illustrated with photos, graphs, and charts. It describes specimen preparation and results obtained with three X-ray techniques: powder camera, diffractometer and spectograph.
North American Philips Co., Inc. 2162

Reactor—The latest issue of "the Nucleus" describes Nuclear-Chicago's role in the new Armour Research Reactor, the Model D-47 gas flow counter for soft beta radiation.
Nuclear Instrument & Chemical Corp. 2163

Parr Bomb Parts—Replacement parts for all Parr bombs, calorimeters, and pressure reaction apparatus are shown in the new 12- and 16-page illustrated price lists.
Parr Instrument Co. 2164

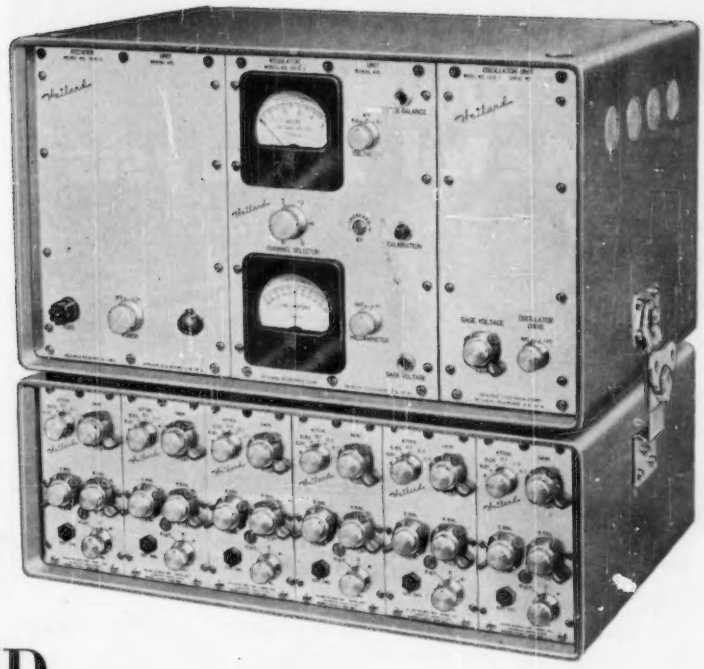
Hydrometers—Two color, eight-page bulletin, on hydrometers and thermohydrometers for use when accurate indications of specific gravity or other density scale are required.
Precision Thermometer & Instrument Co. 2165

Precision Aquatrator—*Data Sheet No. 11259B* on the redesigned Precision Aquatrator for moisture determinations in a wide range of liquid or solid chemicals, foods, drugs, and industrial products is now available.
Precision Scientific Co. 2166

Laboratory Equipment—New 64-page supplement, *Labalog 956*, incorporates a current price list and features many instruments which have been added to the stock.
Schaar & Co. 2167

Polyethylene—New 16-page brochure listing a complete line of polyethylene ware for laboratory use.
Scientific Glass Apparatus Co., Inc. 2168

(*Continued on page 92*)



Carrier Amplifier Units for:
Resistive transducers
Linear differential transformer pickups
Variable reluctance gages

Linear-Integrating Amplifiers for:
Self-generating transducers.

The HEILAND 119 Amplifier System for Oscillographic Recording

COMPARE THESE FEATURES with similar systems:

- **TWICE THE SENSITIVITY**
  ½ millivolt for full current output
- **TWO-THIRDS GREATER FREQUENCY RESPONSE**
  0 to 1000 c.p.s.
- **TEN TIMES THE CURRENT OUTPUT**
  50 ma into 20-ohm load
- **EXCELLENT STABILITY**
  less than 2% variation with line voltage fluctuation and wide range of ambient temperatures

All these features—plus many more—have moved Heiland 119 Amplifier Systems into leadership in the field!

All operating controls are on the front panel; all cabling is on the back panel for handy relay rack or test bench mounting without modification.

The 119 System is flexible to meet present or future needs, since all 6 individual amplifier units within the system are easily removable. You can build your system from the ground up, adding new individual units as your need expands.

In addition, linear-integrate and carrier units are interchangeable within the system case.

FOR ADDITIONAL DETAILS WRITE FOR BULLETIN 101-NN
FOR PERFORMANCE AND CONVENIENCE—CHOOSE THE HEILAND 119 AMPLIFIER SYSTEM.

MINNEAPOLIS
Honeywell
HEILAND INSTRUMENTS
5200 EAST EVANS AVENUE • DENVER 22, COLORADO
FOR FURTHER INFORMATION CIRCLE 365 ON READER SERVICE CARD PAGE 105

SPECTROGRAPHIC EQUIPMENT for Metal Analysis by *Baird—Atomic*

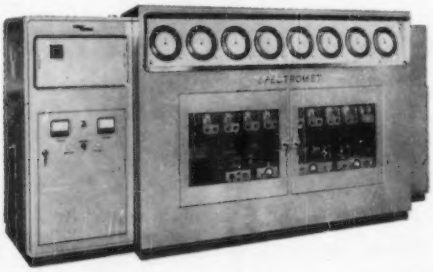
BAIRD ATOMIC

Baird-Atomic offers a complete line of spectrographic equipment for the analysis of metals in production and fabrication.

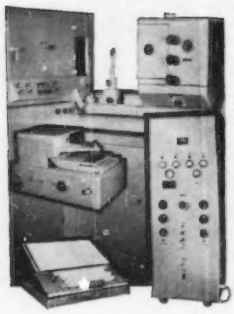
B-A instruments provide rapid, accurate analysis . . simple, stable operation, trouble-free economical performance.

The Direct Reading Spectrometer

Quality-control analytical laboratory for production and research. Simple, rapid operation — forty seconds for complete analysis on dials reading directly in percent concentration. Permanent optical alignment with the Automatic Servo Monitor. Other features include: unique (patented) measuring system . . . plug-in components assuring continuous operation . . . rugged design for plant operation . . . and versatile specimen holders.



Spectromet Designed for production-floor operation by non-technical personnel. Sealed housing provides complete environmental protection of optical and electronic systems. Spectromet provides rapid direct-reading results, extremely simple operation. No critical adjustments. Automatic Servo Monitor for permanent optical alignment. Analysis of eight elements in 40 seconds.



Complete Spectrographic Laboratory

Baird - Atomic, a pioneer in the emission spectrographic instrument industry, offers a complete line of equipment for a spectrographic laboratory. Over twenty years of experience and design are incorporated into the following components: Three-Meter Grating Spectrograph, with its 20-inch camera; Double Beam Densitometer Comparator, employing an optical null-balance system and allowing for direct density measurements on a linear scale; Calculating Board, to easily translate densitometer readings into percent concentration values; and Spectrographic Source Unit, whose versatility supplies a full choice of excitation conditions for all emission problems.

Complete Technical Information Available Upon Request.

Baird Associates—Atomic Instrument Co.

33 UNIVERSITY ROAD, CAMBRIDGE 38, MASS.

CIRCLE 366 ON READER SERVICE CARD PAGE 105

(*Continued from page 90*)

Punch Press—Sample cutting press for textiles, paper, cardboard, leather, rubber, and plastics. Dies to ASTM or customers' specifications.
SMS Instrument Co. 2169

Solavolt—Manufacturer of constant voltage transformers and lighting ballasts, offers on request a technical bulletin on the D-C Solvavolt—a new, adjustable-output, constant voltage d-c power supply.
Sola Electric Co. 2170

INSTRUMENT COMPANY NEWS

Applied Research Labs., Glendale, Calif.—This spectrochemical instrument manufacturing firm will sharply increase its facilities in Europe to meet the demands of expanding European basic metals industries.

Central Scientific Co., Chicago, Ill.—Moved its Newark branch to a new building at 237 Sheffield St. in Mountainside N. J., a Newark suburb.

Consolidated Diesel Electric Corp., Stamford, Conn.—John R. Lawther named production manager for Test Equipment Division.

Consolidated Electrodynamics, Pasadena, Calif.—Hugh F. Colvin, vice-president and general manager since 1953, has succeeded Philip S. Fogg as president. Fogg, as chairman of the board, will continue as chief executive officer.

General Electric Co., Plainville, Conn.—The name of Trumbull Components Department has been changed to the Circuit Protective Devices Department effective June 15, 1956.

Harshaw Chemical Co., Cleveland, Ohio—A wholly-owned English subsidiary, Harshaw Chemical Ltd., has been established with offices, manufacturing plant and laboratories at Waltham Cross, London, England.

Kontes Glass Co., Vineland, N. J.—With the completion of two new buildings, Kontes announces a 70 per cent increase in factory area floor space. Kontes manufactures laboratory and technical glassware for research and industrial use.

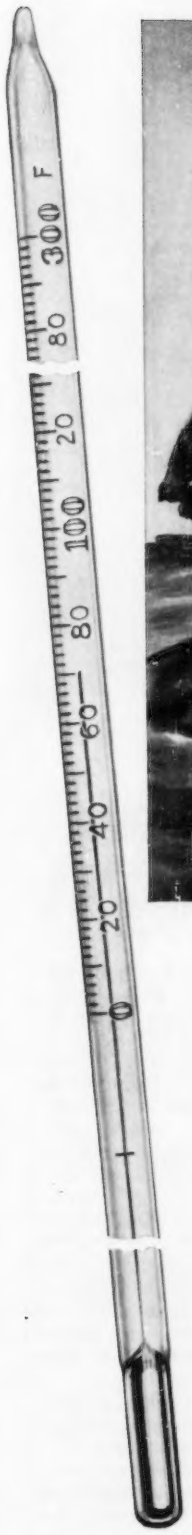
Leeds & Northrup Co., Phila., Pa.—David Vandeventer, has been promoted to division head of the Application Engineering Dept.

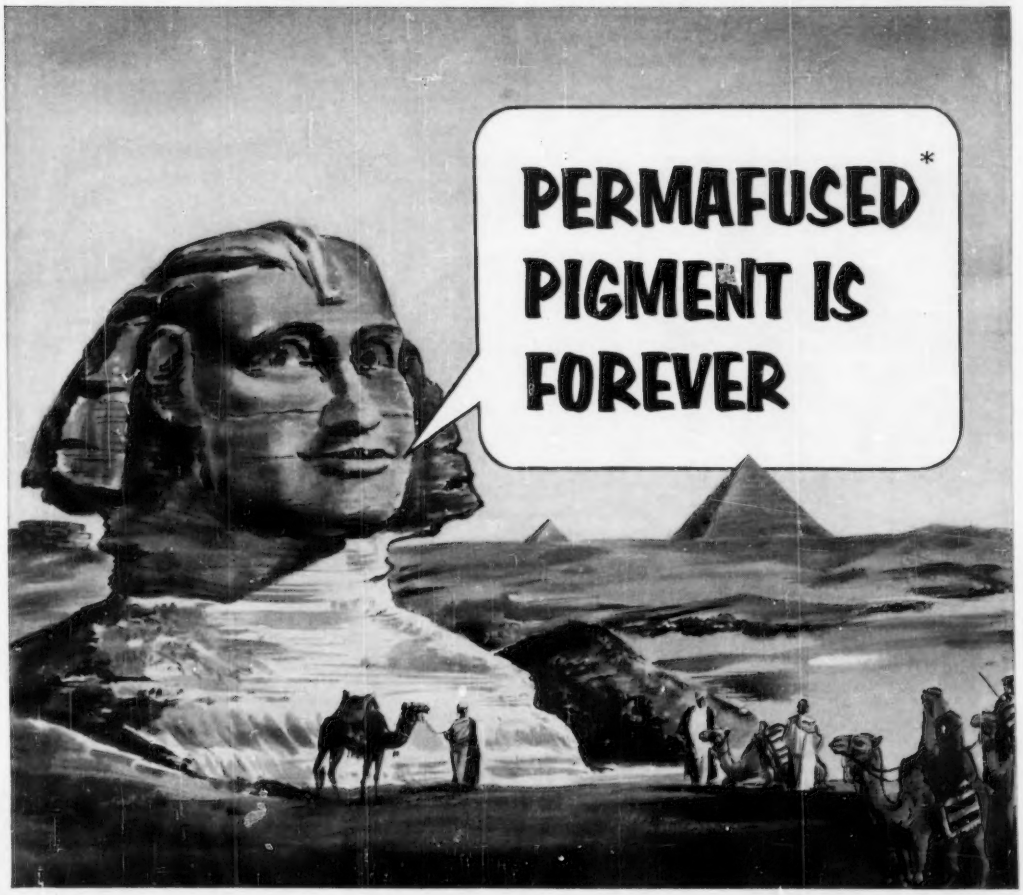
Librascope, Inc., Burbank, Calif.—The Librascope units will be incorporated into the Barton instrument line. Field tests have been completed and the flow computers are now being mass produced by Librascope.

Mine Safety Appliances Co., Pittsburgh, Pa.—To consolidate and expand programs of basic research in the fields of chemistry, physics, and nuclear energy, a new wholly-owned subsidiary, MSA Research Corp., has been formed.

Panellit, Inc., Skokie, Ill.—Panellit, Inc., Skokie, Ill., announces the appointment of Dr. Gimpel to the company's

(*Continued on page 94*)





YOU can read it as long as there's light! That's what Taylor's new PERMAFUSED Pigment means in your laboratory. The markings on Taylor's new etched-stem, mercury-filled laboratory thermometers will last as long as the instruments themselves because PERMAFUSED Pigment is fused directly into the glass . . . *becomes part of it.*

PERMAFUSED Pigment will withstand any solution you test—even organic solvents. The only acids that can harm the markings are ones that attack the glass itself.

PERMAFUSED Pigment frees testing from the danger of contamination by dissolved pigments.

PERMAFUSED Pigment should cut your testing costs because you are *instantly* sure of testing temperatures and don't spoil tests by misreading the thermometer. You buy fewer thermometers, too—every Taylor etched thermometer, ASTM, Plain, Armored or Pocket-Type, is precision-built and expertly annealed for minimum breakage.

The permanent accuracy of the Taylor laboratory thermometer you choose is made certain by skilled workmanship and expert ageing before pointing. Taylor thermometers are available with all scales recognized by the Bureau of Standards. Special designs are made to order for specific scientific, research and production purposes.

PERMAFUSED Pigment means "Legibility That Lasts." For further information on what this can mean in your laboratory, call your Taylor supplier or write for **Catalog LH.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

*Trade Mark

FOR FURTHER INFORMATION CIRCLE 367 ON READER SERVICE CARD PAGE 105

ULTRASONIC TRANSFORMERS by FREED

All ultrasonic components are designed specifically for ultrasonic frequencies using the latest developments in magnetic and insulating materials.

DRIVER and INPUT TRANSFORMERS
Frequency response: ±1Db 10 Kc. to 60 Kc.

Cat. No.	Application	Primary Imp-Ohms	Voltage Ratio	Max. Power Watts	Max. Prim. DC per Side MA.
ULI-20	Transducer to PP811A	1, 2, 4		5	
ULD-30	PP6CM6 to PP811A		4.4:1	5	50
ULD-50	PP5881 to PP8000		1.7:1	25	90

OUTPUT TRANSFORMERS
Frequency response: ±1Db 20 Kc. to 60 Kc.

Cat. No.	Application	Imp. in Ohms Pri.	Imp. in Ohms Sec.	Max. Power Watts	Max. Prim. DC per Side MA.
ULO-10	PP6083 to Transducer	7,600	1, 4	100	120
ULO-11		7,600	2, 8	100	120
ULO-12		7,600	4, 16	100	120
ULO-13		7,600	7.5, 30	100	120
ULO-30	PP811A to Transducer	12,400	1, 4	300	170
ULO-31		12,400	2, 8	300	170
ULO-32		12,400	4, 16	300	170
ULO-33		12,400	7.5, 30	300	170
ULO-34		12,400	25	300	170
ULO-35		12,400	125, 500	300	170
ULO-36		12,400	250, 1000	300	170
ULO-37		12,400	75, 300	300	170
ULO-52	PP8000 to Transducer	10,800	4, 16	500	230
ULO-53		10,800	7.5, 30	500	230
ULO-54		10,800	25, 100	500	230
ULO-55		10,800	125, 500	500	230
ULO-56		10,800	250, 1000	500	230
ULO-101	PP Par. 8000 to Transducer	5,400	25, 100	1000	430
ULO-104		5,400	75, 300	1000	430
ULO-110		5,400	18.8, 75, 300	1000	430

All Components Listed Are Hermetically Sealed.
To save development time a special series of kits are available. These include all reactive components and complete circuit diagrams of the amplifier.

FREED VARIABLE TEST VOLTAGE MEGOHMMETER NO. 1620

The Freed Type 1620 Megohmmeter is a versatile insulation resistance measurement instrument with a continuously variable DC test potential from 50 to 1000 volts.
Components such as transformers, motors, printed circuits, cables and insulation material can be tested at their rated voltage and above, for safety factor.

- Resistance — 0.1 megohms to 4,000,000 megohms.
- Voltage — variable, 50 - 1000 volts.
- Accurate — plus or minus 5% on all ranges.
- Simple — for use by unskilled operators.
- Safe — high voltage relay controlled.
- Self-contained — AC operated.

TYPE 1620C MEGOHMMETER — a type 1620 with additional circuitry for testing capacitors.
TYPE 1020B MEGOHMMETER — a 500 volt fixed test potential. Range 1 megohm to 2 million megohms.
TYPE 2030 PORTABLE MEGOHMMETER — battery operated, 500 volt test potential. Range 1 megohm to 10 million megohms.

Send for NEW 48 page transformer catalog. Also ask for complete laboratory test instrument catalog.

FREED TRANSFORMER CO., INC.
1733 Weirfield St., Brooklyn (Ridgewood) 27, N.Y.
CIRCLE 368 ON READER SERVICE CARD
PAGE 105

(*Continued from page 92*)

Research and Development Dept. Panellit designs, engineers, and builds control and data handling systems for the aircraft, petroleum, electric power, atomic energy, and process industries.

The Sharples Corp., Phila., Pa.—Herbert Trotter, Jr., formerly vice-president of engineering and research, has been named executive vice-president.

United States Testing Co., Inc., Hoboken, N. J.—George Feineman has been appointed an engineer in the Electronics Dept. of the main laboratories at Hoboken, N. J. In this capacity, Mr. Feineman will devise and supervise tests for electronic components. Gerard J. Murphy is being transferred to the position of sales engineer in the Service Div. of the main laboratories.

NEWS OF LABORATORIES

Alco Products, Inc., Schenectady, N. Y.—A new nuclear Criticality Facility for conducting experiments in connection with the company's atomic-power development program has been opened.

Baldwin-Lima-Hamilton Corp., Cambridge, Mass.—A new $3,000,000 plant at Waltham, Mass., now houses the entire Electronics and Instrumentation Div. under one roof. The component operations of this division, manufactures testing instruments, SR-4 strain gages, and testing systems, testing machines, and allied equipment.

Battelle Memorial Institute, Columbus, Ohio—Completion of the nation's first, privately owned nuclear research center was announced by Clyde Williams, president and director of Battelle, following initial "start-up" of the Institute's one-million-watt research reactor.

Bituminous Coal Research, Inc., Pittsburgh, Pa.—Robert D. Saltsman has been appointed project engineer and Robert W. Stephan chemical engineer at the Pittsburgh laboratory.

Custom Scientific Instruments, Inc., Kearny, N. J.—Uster Corp. will be sole distributor for the Custom Tension Recordograph, developed by Celanese Corp. of America, and manufactured by Custom Scientific Instruments, Inc.

Evans Research & Development Corp., New York, N. Y.—Two new members, C. Edgar Chamberlain and Ralph L. Evans, Jr., have been elected to the Board of Directors of this chemical consulting firm.

Fairchild Camera & Instrument Co., Syosset, N. Y.—R. H. Frye has been appointed general manager of the electronics Div. and Maj. Gen. Kenneth P. McNaughton, USAF, (Ret.) has been elected vice-president.

Lowell Technological Institute, Lowell, Mass.—Gov. Christian A. Herter has signed into law the Commonwealth of Massachusetts' appropriation of $2,108,000 for a new four-story building at Lowell Technological Institute, which will primarily house the electronic and plastics engineering departments and general engineering laboratories.

Logistics Research, Inc., Redondo Beach, Calif.—Abbot Kinney has been named applications engineer in charge of the firm's New York branch. He will represent the company's complete product line of electronic data processing equipment including ALWAC digital computers.

Minneapolis-Honeywell Regulator Co., Phila., Pa.—Has purchased Davies Laboratories, Inc., of Beltsville, Md., manufacturer of specialized high-speed data recording systems.

National Carbon Co., New York, N. Y.—This Division of Union Carbide and Carbon Corp. has opened a 175,000 sq ft laboratory in suburban Cleveland, Ohio containing 158 individual working areas to further the research of the company.

Stauffer Chemical Co., New York, N. Y.—The merger of West End Chemical Co. into Stauffer Chemical Co. was approved by the stockholders of both companies at special meetings.

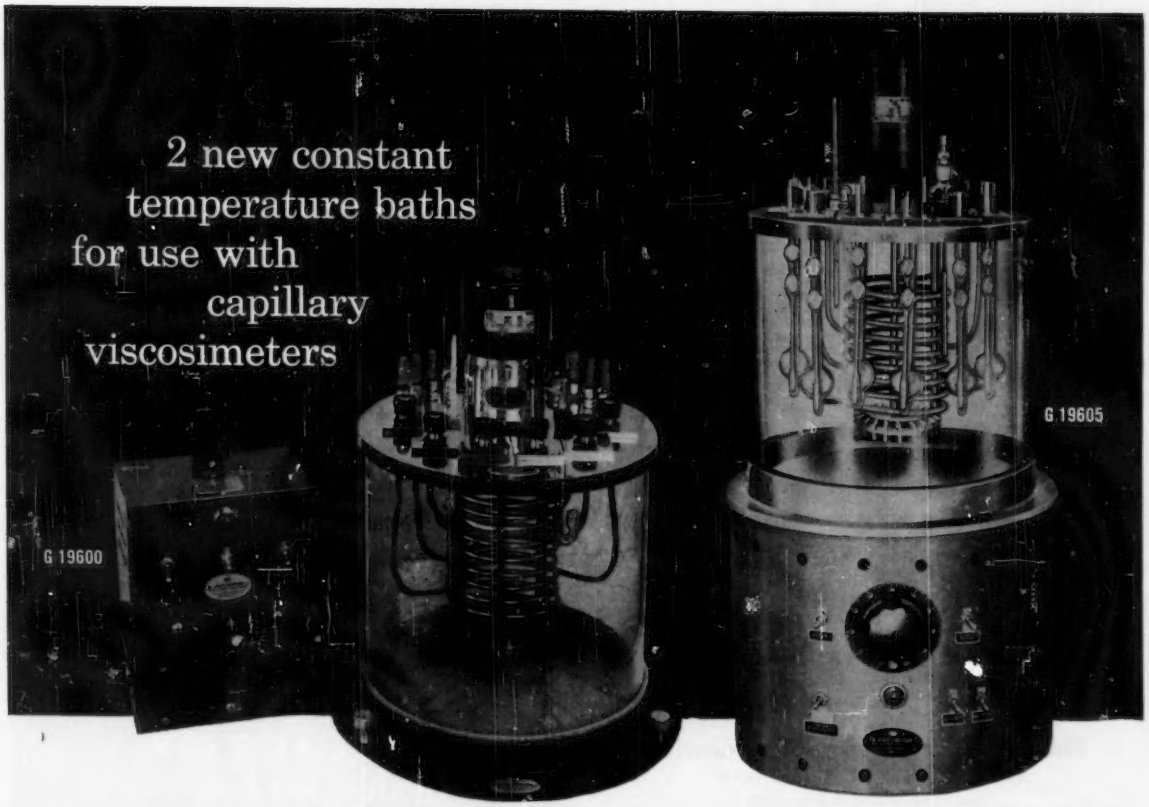
Arthur H. Thomas Co., Phila., Pa.—Warehouse and offices have moved into a seven-story building at the southwest corner of Third and Vine Streets, Philadelphia.

Engineering Societies to Remain in New York

United Engineering Trustees, Inc., the joint corporate agency of the four national engineering societies, has signed a contract for preliminary architectural plans and studies for a new Engineering Center in mid-Manhattan, New York City. This is the first definite step toward construction of what is expected to make New York the "engineering capital of the world."

The four member societies of UET—American Society of Civil Engineers, the American Institute of Mining, Metallurgical, and Petroleum Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers—will be joined by a fifth, American Institute of Chemical Engineers, in the Center project.

Decision of the group to remain in New York came after a long period of consideration of sites or locations offered by other cities of the United States. Space in the present 16-story structure, known as the Engineering Societies' Building, which housed the four founder societies and the Engineers' Joint Council, has for some time been inadequate.



KINEMATIC VISCOSITY BATHS

These new kinematic viscosity baths, completely unitized to require a minimum of table space, are the simplest and most convenient yet designed for attaining and maintaining desired test temperatures in capillary viscosimeters... while allowing perfect observation at all times.

G 19600
Constant Temperature Water Bath
for use with Capillary Viscosimeters. A.S.T.M. No. D445-46T, I/P. 71/45T

A highly sensitive apparatus to hold constant temperature in any part of the bath within ±0.02°F., over the entire temperature range. This bath will operate from below room temperature, with cooling coil, up to 210°F., without any additional heaters. Although light mineral oil or ethylene glycol mixture can be used for the bath liquid, this apparatus has been designed so that water can be used over the entire temperature range.

Supplied complete as illustrated, with thermoregulator and six receptacles to mount tubes, but without thermometers or viscosimeters.
For 115 Volt, A.C. or D.C. Each.....$275.00
for 220 Volt add $8.50 to List Price
Larger baths to hold up to 12 (Fenske or Ubbelobde) Viscosimeter tubes, to order.

G 19605
Unitized Constant Temperature Bath
for use with Capillary Viscosimeters. A.S.T.M. No. D445-46T. I/P. 71/45T

Circular fluorescent light in base illuminates entire bath and viscosimeters. Glass jar has frosted base to eliminate glare and to diffuse light over entire area.

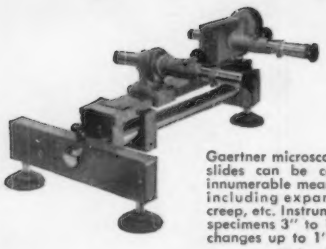
A new type of turbine stirrer provides perfect temperature distribution, thoroughly and rapidly agitating the liquid medium, without any vortex, surface turbulence, or air entrainment to mar observations. Quickly reached operating temperatures and maximum operating temperatures are both assured by three adequately rated heaters. (The bath will hold at test temperature despite a substantial voltage drop in current supply). Heaters and cooling coil are easily accessible, with open distribution of these elements doing away with the inconvenience of old type throttling tubes, while giving greater sensitivity and efficiency. The continuous heater is regulated by a Powerstat, to allow for perfect setting of the bath at operating temperature... almost independent of the thermostat... and with no wasteful rheostat to dissipate current energy.

Supplied complete as illustrated, with thermoregulator and six new type tube holders, but without thermometer or viscosimeters. For 115 Volts, 50-60 cycles A.C.....$450.00

In ordering, specify if bath is to be used for modified Ostwald or Ubbelobde type capillary viscosimeters.

The EMIL GREINER Co. E&Co® 20-26 N. MOORE STREET, DEPT. 229 N. Y. 13, N. Y.

FOR FURTHER INFORMATION CIRCLE 369 ON READER SERVICE CARD PAGE 105



INSTRUMENTS TO MEASURE LINEAR DIMENSIONAL CHANGES

Gaertner microscopes and micrometer slides can be combined to satisfy innumerable measuring requirements, including expansion, contraction, creep, etc. Instrument above measures specimens 3" to 10" long and length changes up to 1". Reads to 0.0001". Write for details

For help with your optical instrumentation problems, call on Gaertner experience

Whatever your optical instrumentation problem, Gaertner Scientific Corp. can probably recommend a standard or modified instrument to meet your particular needs. If one is not available, we are fully equipped to design and build special instrumentation.

Gaertner has designed and built precision, scientific, optical and measuring instruments for 60 years. Write or phone, and put this experience to work for you.

The Gaertner Scientific Corporation

1215 Wrightwood Ave., Chicago 14, Ill.
Telephone: BUckingham 1-5335

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Mullen Testers

Built to ASTM Specifications

Also Available in Capacities up to 1500 Pounds Bursting Strength

B. F. PERKINS & SON, Inc.
HOLYOKE, MASSACHUSETTS

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Bookshelf

(Continued from page 63)

Polymer Processes

C. E. Schildknecht, Ed.; High Polymers, Volume X; Interscience Publishers, Inc., New York; 914 pp.; $19.50.

"POLYMER, *n.*—A compound formed by the reaction of simple molecules having functional groups that permit their combination to proceed to high molecular weights under suitable conditions. Polymers may be formed by polymerization (addition polymer) or polycondensation (condensation polymer). When two or more monomers are involved, the product is called a copolymer" (from ASTM Definitions D 883 – 55 T).

Though the above ASTM definition applies specifically to plastics and adhesives, it is equally applicable to synthetic rubbers, fibers, and resins.

Polymer Processes in a broad sense is concerned with the chemical technology of plastics, resins, rubbers, adhesives, and fibers. All these materials derive their properties from the chemical building blocks, the polymerization conditions, and the subsequent shaping, forming, or drawing operations involved in their manufacture.

This welcome addition to the Interscience High Polymers series compiled by 20 outstanding authors and capably edited by C. E. Schildknecht is devoted to basic processes in the polymer field particularly with a view to bridging the gap between theory and practice. Of the eleven monographs so far published in the polymer series, this book is the longest, covers the widest scope, and is the most expensive. Complete books have been written on subjects covered by single chapters in this book, and the treatment is by necessity somewhat sketchy, though plentiful references to other works are provided.

The book will probably be quite useful to the engineer who is often too busy with day-to-day problems to do much hunting in the polymer-chemistry literature. Here the digging has been done for him. The book will also be of value to the polymer chemist who can profit from an understanding of the techniques and problems of the engineer dealing with polymeric materials and thus be in a better position to recognize possible applications of new polymers which he prepares in the laboratory.

As in all our technology, a better understanding and working relationship between the scientist and the engineer are worthwhile objectives, which this book fosters in the polymer field. Unfortunately the rather steep price of $19.50 may keep it out of the collections of many who could use it to advantage.

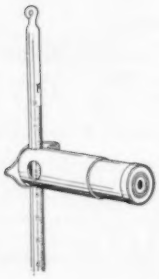
F. Y. S.

New ACI Standards

American Concrete Inst., 18263 W. McNichols Rd., Detroit, Mich.

Two ACI Standards have been published as separate paper-bound prints: Recommended Practice for Winter Concreting, 75 cents; Building Code Requirements for Reinforced Concrete, revised edition, $1.

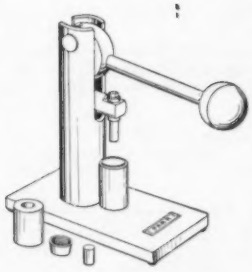
Selected PARR Items
For General Laboratory Use



THERMOMETER READING LENS

A 3-power magnifier in a telescopic mounting. Easily clamped on any thermometer or burette of 6 to 16mm. diameter.

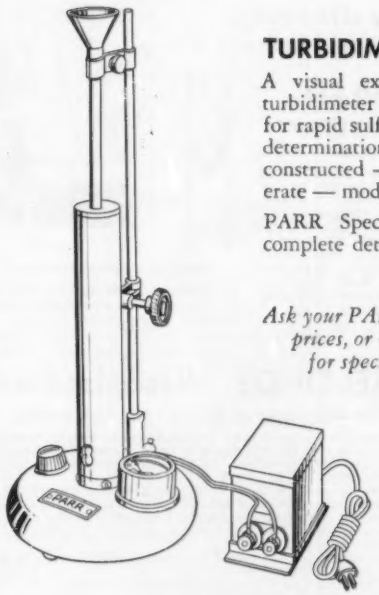
PARR No. 3003



PELLET PRESS

A convenient hand operated press with interchangeable stainless steel punch and die sets for compressing powdered materials into pellets or tablets. Punch and die sets available in three sizes: ½" dia., ⅜" dia., ¼ dia.

PARR No. 2811



TURBIDIMETER

A visual extinction type turbidimeter used mainly for rapid sulfur and sulfate determinations. Sturdily constructed — easy to operate — moderately priced.

PARR Spec. 2400 gives complete details.

Ask your PARR Dealer for prices, or write direct for specifications.

PARR INSTRUMENT CO.

MOLINE, ILLINOIS

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ACCURACY

IN TEST RESULTS

is greatly increased by positive control of specimen temperatures

in the Model DMC

WEATHER-OMETER ®

A constant volume of air at a controlled temperature in the heavily insulated cabinet, maintains uniform predetermined specimen temperatures regardless of variations in room conditions.

Automatic control of humidities up to dew point is available as optional equipment.

All automatic controls are located on the front panel of the Weather-Ometer directly above the door of the test chamber.

Both horizontal and vertical testing is available. Shallow containers are used for semi-liquid materials and vertical panels for solid materials.

Source of radiation is two Atlas enclosed violet carbon arcs.

Complete technical information on the DMC Model and other Weather-Ometers is contained in the new Weather-Ometer catalog. Copy on request.

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ISO 61

(*Continued from page 62*)

(2) Detection of Free Ammonia in Phenol-Formaldehyde Moldings, (3) Determination of Styrene in Polystyrene with Wijs Solution, and (4) Determination of Viscosity Number of Polyvinyl Chloride Resins in Solution.

The Working Group on Aging, Chemical, and Environmental Resistance prepared three new Draft ISO Proposals covering the determination of the thermal stability of polyvinyl chloride and related copolymers and their compounds by (1) Congo Red Method and (2) Discoloration Method and a Method for Determining Bleeding of Colorants from Plastics. They also approved three methods for circulation as Draft ISO Recommendations: (1) Change in Weight and Dimensions of Plastics after Contact with Chemical Substances; (2) Loss of Plasticizers from Plastics; and (3) Migration of Plasticizers from Plastics.

Progress is being made by the Working Group on Preparation of Test Specimens. Preliminary drafts were considered by the Group as follows: (1) recommended practice for injection molding test specimens of thermoplastic materials; (2) recommended practice for compression molding test specimens of thermoplastic materials; and (3) recommended practice for compression molding test specimens of thermosetting materials. These will probably be ready for circulation as Draft ISO Proposals in 1957.

The Working Group on Electrical Properties reviewed documents received from the International Electrotechnical Commission, Technical Committee 15 including (1) method of test for volume and surface resistivity of electrical insulating materials and (2) method for determining the conventional tracking voltage of solid insulating materials under moist conditions.

American Delegation

Represented in the U. S. delegation were Government, trade society, and industry, as follows:

C. H. Adams, Monsanto Chemical Co, leader
W. E. Brown, Dow Chemical Co.
R. Burns, Materials Advisory Board, National Academy of Sciences
C. L. Condit, Society of the Plastics Industry
G. M. Kline, National Bureau of Standards
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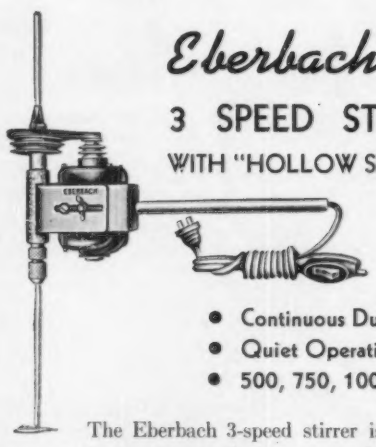

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OTHER SOCIETIES' EVENTS

January 10–11, 1957—**American Society for Engineering Education,** Cooperative Engineering Education Div., Northeastern University, Boston, Mass.

January 14–16, 1957—**Third National Symposium on Reliability and Quality Control in Electronics,** Hotel Statler, Washington, D. C., sponsored jointly by ASQC, IRE, AIEE, RETMA.

January 16–18, 1957—**Society of Plastics Engineers, Inc.,** 13th National Technical Conference, Sheraton-Jefferson Hotel, St. Louis, Mo.

January 18, 1957—**Malleable Founders' Society,** Semiannual Meeting, Hotel Cleveland, Cleveland, Ohio.

January 21–25, 1957—**American Institute of Electrical Engineers,** Committee on Technical Operations, 1957 Winter Meeting, Hotel Statler, New York, N. Y.

January 28–February 2, 1957—**American Road Builders' Assn.,** Road Show and Convention, International Amphitheatre, Chicago, Ill.

January 28–31, 1957—**10th Annual Symposium on Modern Methods of Analytical Chemistry,** Louisiana State Univ., Baton Rouge, La.

January 30–31, 1957—**American Society for Engineering Education,** Relations with Industry Division, College-Industry Conference, University of California (Los Angeles), Los Angeles, Calif.

February 1–2, 1957—**American Society for Engineering Education,** Engineering Drawing Div., Rice Institute, Houston, Tex.

February 5–7, 1957—**Society of the Plastics Industry,** 12th Conference of Reinforced Plastics Div., Edgewater Beach Hotel, Chicago, Ill.

February 11–14, 1957—Joint Conventions of the **National Sand and Gravel Assn. and the National Ready Mixed Concrete Assn.,** Hotel Statler, Los Angeles, Calif.

February 14–15, 1957—**American Society for Quality Control,** Mid-Atlantic Conference, Benjamin Franklin Hotel, Philadelphia, Pa.

February 14–15, 1957—**Wisconsin Regional Foundry Conference,** Hotel Schroeder, Milwaukee, Wis.

February 18–22, 1957—**American Society of Civil Engineers,** Convention, Jackson, Miss.

February 21–22, 1957—**Southeastern Regional Conference** sponsored by Birmingham and Tennessee chapters, AFS, Dinkler-Tutwiler Hotel, Birmingham, Ala.

February 24–28, 1957—**American Institute of Mining and Metallurgical Engineers,** Annual Meeting, Roosevelt and Jung Hotels, New Orleans, La.

February 25–28, 1957—**American Concrete Inst.,** Annual Meeting, Statler-Hilton Hotel, Dallas, Tex.

February 25–28, 1957—**American Society of Heating and Air-Conditioning Engineers,** 63rd Annual Meeting, Conrad Hilton Hotel, Chicago, Ill.

February 25–March 1, 1957—**American Society of Heating and Air-Conditioning Engineers,** 13th International Heating and Air-Conditioning Exposition, International Amphitheatre, Chicago, Ill.

February 26–28, 1957—**Western Joint Computer Conference,** Hotel Statler, Los Angeles, Calif., sponsored by IRE, AIEE, and ACM.

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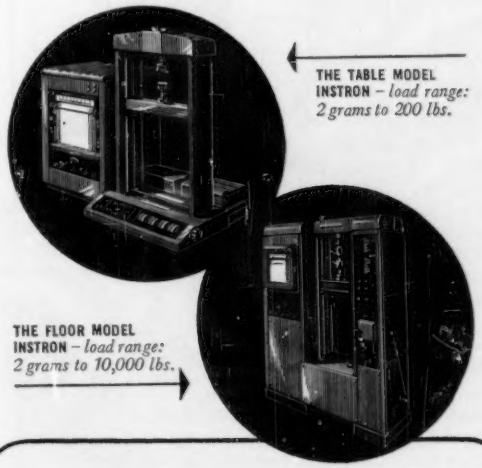

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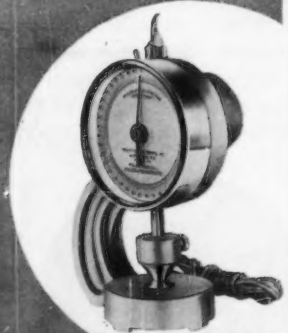

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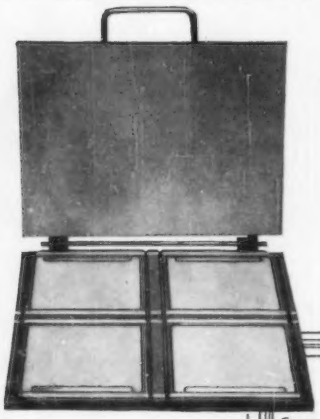

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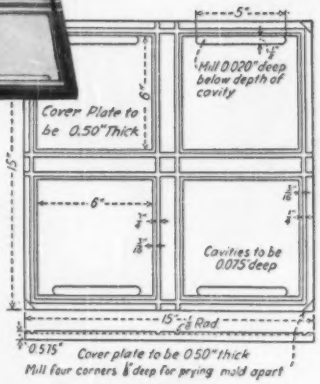

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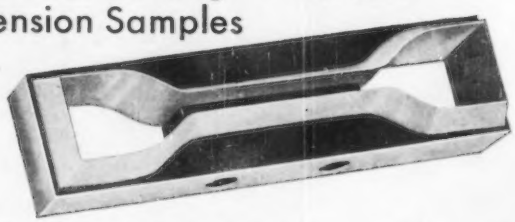

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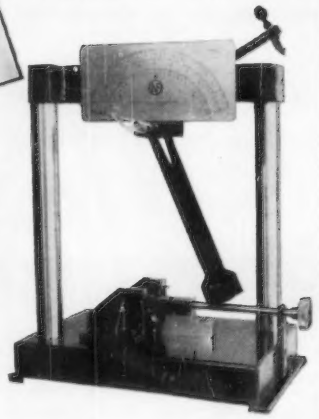

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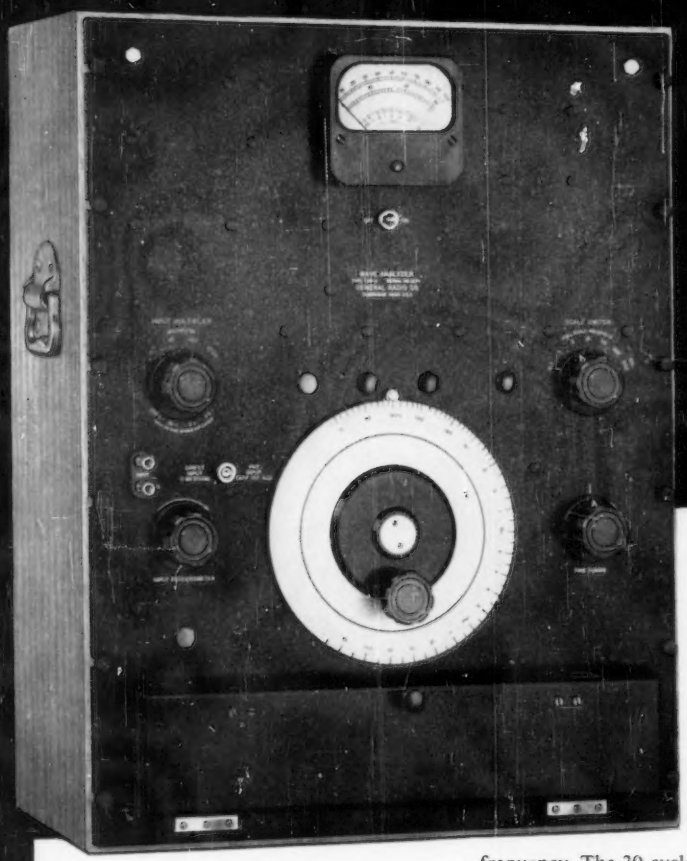

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This Analyzer provides the most accurate and direct method of separating the components of a complex electrical waveform so as to measure their amplitudes and frequencies. In its essentials it is a heterodyne-type vacuum-tube voltmeter which utilizes a unique network of three quartz-crystal filters for selectivity and exceptional sharpness of tuning.

Ease of use is an important feature. The instrument is direct reading over a very wide voltage range of 10 microvolts to 300 volts inclusive, and when making comparative measurements, harmonics can be identified as low as 80 db below the fundamental frequency. The 30-cycle off-resonance selectivity is down at least 60 db . . . a factor of 10-1 better than that of any comparable instrument.

The Wave Analyzer is ideally suited for measurements on all kinds of audio-frequency equipment, oscillators, amplifiers, telephone and public address systems, broadcast receivers and transmitters and other vacuum-tube circuits. Noise and hum measurements and analyses are also possible. As a sharply tuned voltmeter, the Wave Analyzer is invaluable in the measurement of the transmission characteristics of electrical wave filters. In addition, it has wide application outside the electronics laboratory, as in the determination of harmonics of electrical power systems and electrical machinery.

Frequency Range: 20 cycles to 16 kilocycles

Frequency Calibration Accuracy: ±(2% + 1 cycle)

Selectivity: substantially flat 4-cycle bandpass over frequency range — see typical quartz-crystal filter characteristic at right

Input Voltage Range: 0.0003 to 300 volts full scale

Voltage Accuracy: within ±5% on all ranges

Modulation Products Suppressed: by at least 70 db

Hum Suppressed: 75 db

Input Impedance: 1 megohm for direct voltage measurements; 100,000 ohm with input potentiometer

Built-in Calibration System: for both voltage and frequency

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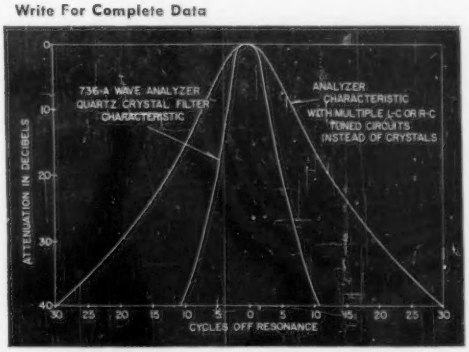
Quartz-Crystal Filters for Flat-Top Response . . . and Steep Skirt Drop-Off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